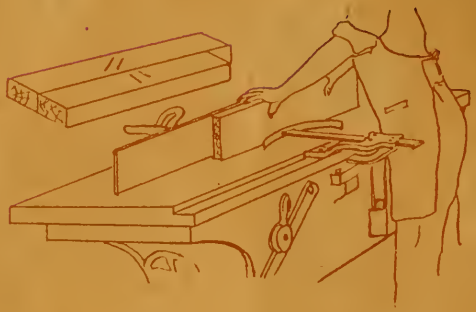
MACHINE WOODWORKING

Shop Notes and Note Book

JENSEN



MACHINE WOODWORKING

Shop Notes, Note Books and Text, for Schools that use Machines in Connection with Woodworking. This includes High Schools and Colleges as well as Prevocational and Elementary Industrial Schools.

BY
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TO THE BOYS WHO ARE
STRIVING FOR A MORE USEFUL FUTURE,
TOWARDS SOCIETY
AS WELL AS TO THEMSELVES.

PREFACE

Machine Wood-Working has been prepared for the purpose of furnishing specific and detailed information concerning the machines generally found in **Manual Training** and **Industrial School Wood-Working Shops.** A special effort has been made to compile this information in connection with the standard trade practices and to point out practical safe-guards, "Insisted on by law in most states" and written in detail for California in chapter XVI. Too much emphasis cannot be placed on the necessity and use of safe-guards. The shop rules in chapter I should at all times be rigidly enforced as it will have the effect of reducing accidents to zero.

The text also provides ample blank sheets to take the place of a note book which would otherwise be necessary in addition to the text.

When using **Machine Wood-Working** as a text, the assignments should be sections or articles that relate to the work being done and not necessarily by page sequence.

This material was prepared last year but could not be printed since other important demands were being made on the print-shop at the Prevocational School. It has been used by the author in abbreviated form in his summer school classes for several years, particularly at the University of California. Also in his own public school class teaching for years and has been found to be very helpful and practical.

The author takes this means of acknowledging the cuts and other material so generously contributed by the manufacturers as follows:-

Oliver Machinery Co., Grand Rapids, 1, 2, 3, 39; American Woodworking Mach. Co., Rochester, N. Y., 13, 35, 36, 38, 46, 52; Henry Disston & Sons, Philadelphia, 18, 19, 20, 21, 22, 24, 25, 27, 28, 29, 30, 31, 32, 33, 34, 37, 40, 41, 42, 43, 44A; Grand Rapids School Equipment Co., Grand Rapids, 12, 14, 15; Russel Jennings Mf'g Co., Chester, Conn., 49; Mummert Dixon Co., Hanover, Pa., 26, 53, 54; F. E. Wells & Sons Co., Greenfield, Mass., 50; The Fox Machine Co., Grand Rapids, 58,

CONTENTS AND LIST OF ILLUSTRATIONS

NOTE: Blank sheets in front as well as back to be used for notes.
—The Author.

CHAPTER I

INTRODUCTION

1. Introduction-- Before endeavoring to learn how to use the machines the student should come to a realization of the danger involved in the use of any machines in the wood-shop, through careless or indifferent operation. Machines even when properly safeguarded are always dangerous to the careless operator. "Safety First" becomes a reality in the shops where these machines are used. It is necessary at all times to concentrate on the particular work which you are doing and not to pay any attention to what is going on at other machines, or in other parts of the room.

The machines in these chapters are described in the order used when milling material for any job, so far as possible. However, by looking over the contents it will be seen at once that it may be necessary to grind the jointer knife or file a saw before these have been studied. The order of the machines is similar to that of the squaring up process when working at the bench using hand tools.

Never hurry if you would avoid accidents.

The following shop rules should be observed at all times:

1. All machines in this shop are properly **equipped with safety devices.** Belts and motors are housed and enclosed so as to eliminate all danger of burning the operator.

2. However, the **machines are dangerous** when used by a careless operator, or, when operated in a careless manner.

3. No student should **ask permission** to use any of the machines until he has been properly taught by the instructor how to use same—first, in class demonstration, then by individual questioning and demonstration.

4. Each time a student wishes to use any machine, he must first **get permission** from his instructor to do so, even though it is necessary for him to use a machine or machines, more than once during a period.

CHAPTER II

SWING CUT-OFF SAW

2.-- General The swing cut-off saw, Fig. 1, is supported from the wall and ceiling and has a large counterweight to pull it back to the wall after making a cut. The frame is of heavy cored construction and rests against the wall back of the table when not in use. The table has rollers, the face of which are slightly higher than the table. This is done in order to make it easier to move the stock while working at the saw. The motor rests in the top of the frame and drives the saw by means of an endless belt. In the best types of saw the construction is such that the belt can be tightened without cutting it. Figures 1 and 2 show the slotted holes just above the arbor which permits of this adjustment. Another advantage of this construction is that the saw arbor may be removed from the frame for rebabbeting the bearings.

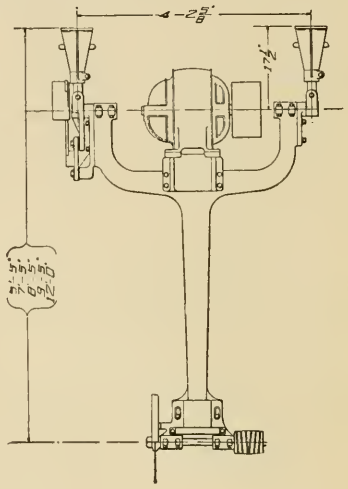


FIG. I.— SWING CUT-OFF SAW.

This machine, while not as dangerous as some of the other machines in the mill room, must be properly guarded in order to insure maximum safety to the careful operator.

The swing frame should have a knuckle guard, one type of which is illustrated in Fig. 2. In this case the wire belt forms the knuckle guard. The saw itself should also be guarded, and an excellent type of guard for this purpose is shown in Fig. 2. A study of the figure will reveal to you that as the saw leaves the wood. the guard is lowered, dropping back and covering the saw when not in use.

3. Use-- This machine is used when milling stock. Its purpose is to cut stock to length and should not be used for squaring the ends of pieces to finished lengths, although some manufacturers state that their swing saws will cut accurately enough for this. You will readily see that a swing cut-off saw is a necessity in every modern mill room because the long pieces of stock cannot be cut to length advantageously on the saw table.

4. Operation-- Note that the back of the table is graduated so as to cut any particular length without marking. Place the board in position so that the proper length can be cut. (A stop may be clamped to the back of the table if a number of pieces of the same length are to be cut.) Grasp the handle firmly and do not pull the saw into the wood too rapidly. The motion of the saw is down and into the wood and for this reason if you do not have a firm hold, or have started too swiftly, the saw will stick and the belt will slide. Should this happen, keep a firm handhold and push the saw back until it begins to revolve again.

5. Speed and Power-- A three horse power motor will afford sufficient power for ordinary work. In large mills where very heavy stock is cut a larger motor is necessary. When using the 14″ saw it should run at the rate of 3000 RPM.

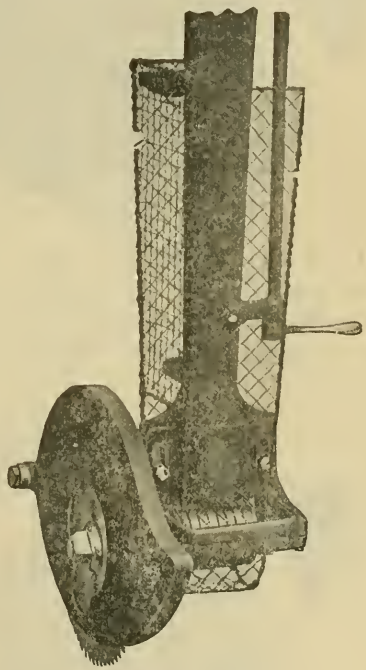


FIG. 2— SWING CUT-OFF WITH BELT AND KNUCKLE GUARD, ADJUSTABLE SAW GUARD, AND ADJUSTMENT FOR TIGHTENING BELT.

CHAPTER III

JOINTER OR BUZZ PLANER

6. **GENERAL--** The jointer, Fig. 3, also called buzz planer, may be used for quite a wide range of work if properly manipulated. Its original purpose was to plane a working face or to take wind out

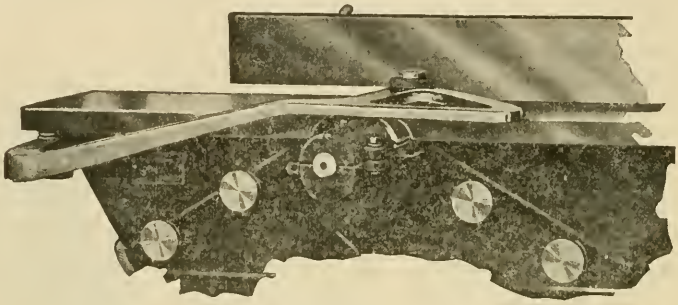


FIG. 3--JOINTER WITH FLAP GUARD.

of a surface and to plane an edge at right angles to that face. It is also used for planing glue joints and dadoing. Fig. 6, shows a jointer with parts labeled.

7. **THE HEAD--** Formely all jointers were equipped with square heads, illustrated in Fig. 4, but these are so much more dangerous to the operator because of the fact that in case of accident one is apt to have an entire hand or at least most of the fingers of the hand drawn into the machine. This can be verified by comparing the larger opening, Fig. 4 with that of the circular head, Fig. 5. While it is still dangerous to the operator to get his fingers in the machine,

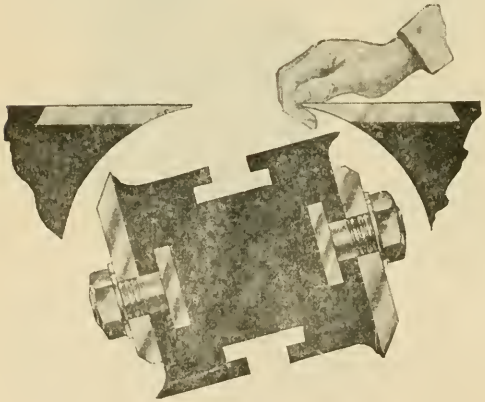


FIG. 4.—SQUARE HEAD.

8. Tables-- The tables, Figure 6, are mounted in such a way that they can be drawn from the cutter head on a level, independently of the device for raising and lowering them. The best tables are provided with steel lips located close to the cylinder head. When the lips are of the same material as the other parts of the table they are not as serviceable. The front table, or the one at which the operator stands when he begins to run a piece of wood over the jointer, is the one that determines the size of the cut to be made on a piece of stock. The most desirable type is the one that has a hand wheel, Figure 6, on the back side of the table and permits the operator to stand in front of the machine while adjusting the depth of the cut. With the old type it is necessary to get down and reach below the machine to make this adjustment.

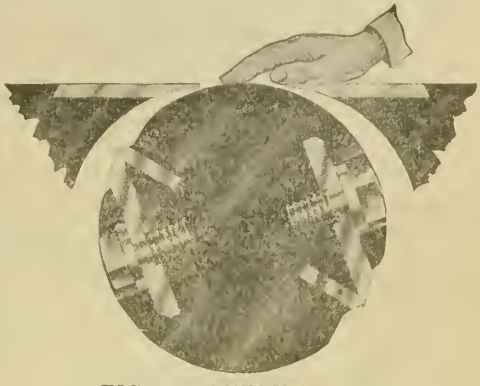


FIG. 5—SAFETY HEAD

The back table should not be adjusted except with the assistance or permission of your instructor. It is easily gotten out of adjustment if tampered with by a novice. This may cause an accident, resulting in disfugured knives and an injured operator.

9. Operation.-- Assume the position in Figure 6 and be careful at all times that you do not slip, which may result in a bad accident to hands or fingers. A piece of rubber matting nailed to the floor is a great aid to easier and safer operation. Cleats are sometimes nailed to the floor when matting is not available, but are an inconvenience when sweeping.

10. Working Face -- To plane a working face assume the position shown in Fig. 6. The piece to be planed is placed on the front table after being certain that the gauge is set for the proper thickness and pushed slowly over the revolving cylinder, being careful at all

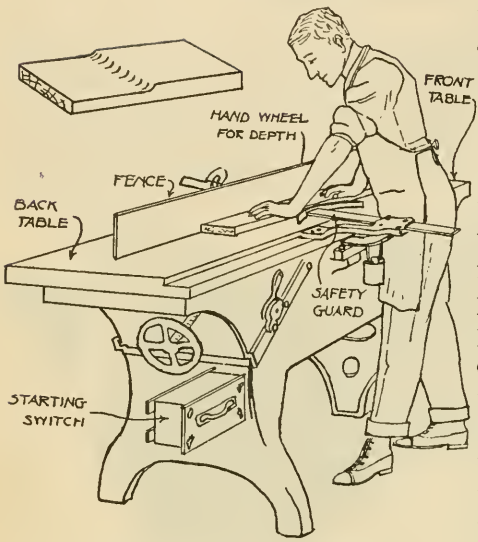


FIG. 6— WORKING FACE

times to keep the stock firmly on the table. This may be accomplished with both hands on the surface of the board being planed. A precaution must always be taken, especially with beginning students by using the wooden mitten shown in the top of Fig. 7. This is placed in the back end of the piece which is being shoved over the jointer. Again referring to Fig. 6, it will readily be seen how easily it is to drop the right hand down upon the revolving cylinder thus causing a very serious accident, which can be avoided by the use of the mitten and push stick, which is also shown in Fig. 7. Be sure at all times to use the safety guard. There is only one exception to this which will be noted later. Always run the stock so that the knife will cut with the grain.

11. Jointing An Edge-- Planing a working edge on the jointer is similar to squaring up a working edge at the bench. The piece is set against the fence and fed very slowly in a manner similar to that shown in making a working face Fig. 6. If the stock is wide so that the top edge comes above the fence and fed very slowly it will not be necessary to use the mitten or push stick. It is best always to feed the stock so that it will

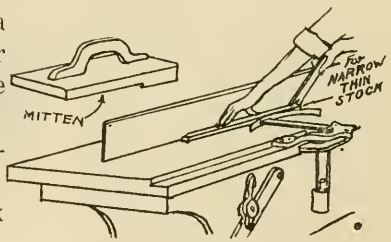


FIG. 7— USING A PUSH STICK FOR NARROW STOCK.

cut with the grain, however, fairly good work can be done joining against the grain if fed very slowly.

12. Chamfering-- The jointer may be used for chamfering as illustrated in Fig. 8, by tilting the fence so as to cut the desired angle. Remember that the rule learned in hand planing, to plane the end grain first still holds good.

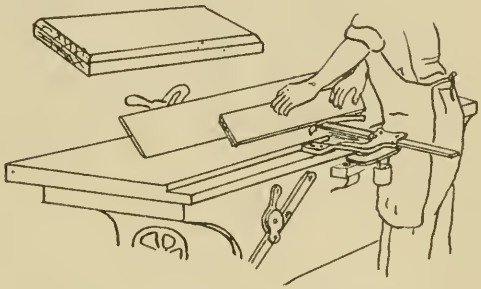


FIG 8—CUTTING A CHAMFER

13. Rabbeting-- When using the machine for rabbeting it is necessary to remove the jointer guard. This should be put back as soon as the operator has completed the rabbeting, because a guard should be attached at all times for regular jointing. As a rule, machines are equipped with rabbeting arms (brackets). It is not possible to do efficient rabbeting without them.

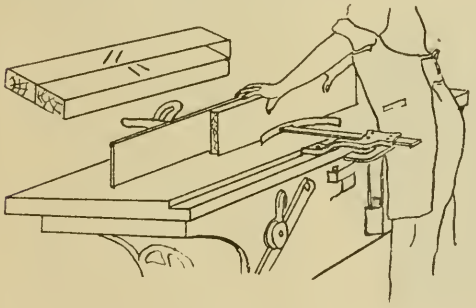


FIG 9—JOINTING AN EDGE

14. Sharpening-- For grinding of jointer knives refer to the chapter on grinding. After grinding, it is necessary to set the knives very carefully. To get them quite true, place a try square on the back table so that the end of the blade projects out over the knife------ test in this manner for the entire length of both blades, and tighten very securely. Then joint, by using the device shown in Fig. 11.

15. Speed And Power--The jointer should be run at the rate of 4500 R. P. M. The small 4 inch bench jointer is usually equipped with a 1-4 H. P. motor and the cylinder should be run at the rate of 5200 R. P. M

8 inch 2 H.P. and cylinder 5000 R.P.M.; 12 inch 3 H.P. and cylinder 4800 R. P. M.;16 inch 3 to 5 H·P. and cylinder 4400 R.P. M.; and 20 inch 3 to 5 H.P. and cylinder 4000 R.P.M. The cylinder is usually equipped with a 4 inch pulley.

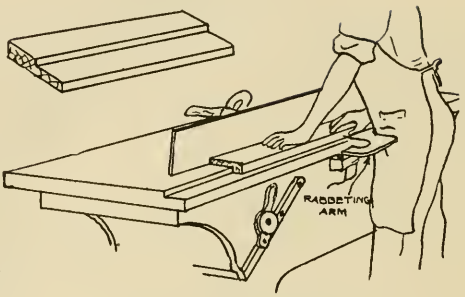


FIG 10— RABBETING

16. Points Always to be Observed While Operating the Jointer.

1. Be sure that the back table is properly adjusted and locked, and that the fence (guide) is fastened so as to give the angle you are attempting to cut.

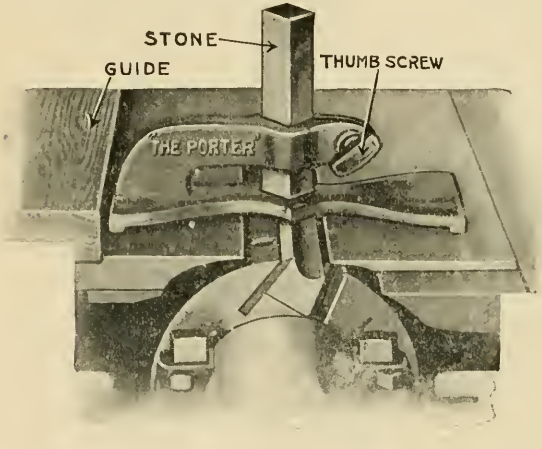


FIG. 11—JOINTING DEVICE

2. Use a guard at all times, except when dadoing. Good types are shown in Figs. 5 and 6.

3. Use a wooden mitten or specially provised stick (Fig. 8) of some kind in pushing flat and narrow pieces over the revolving cylinder.

4 Be sure to inspect the depth of the cut and see that the fence is locked before beginning to push stock over it. Do not change the fence when cylinder is in motion.

5. For good work, push the stock over the jointer slowly. It is

best to have the knives cut with the grain.

6. For straight cutting and in making joint edges be sure that the stock follows the rear table. (This means to keep it flat on the rear table from the time it leaves the jointer head.

7. To straighten a curved piece of stock, begin on the crowned edge or side. Begin on one side of crown and stick to it until you have a straight edge.

8. If the rear table is too high it leaves a crowned edge, if too low, a hollow edge.

9. Do not use a jointer for planing to thickness. After the work ing face has been cut, the stock should be taken to the planer.

CHAPTER IV

SAW TABLE

(Circular Saws - How to Fit and Use them.)

17. General-- The saw tables or circular saws as they are also called are used in two types as a general rule. One of these is known as

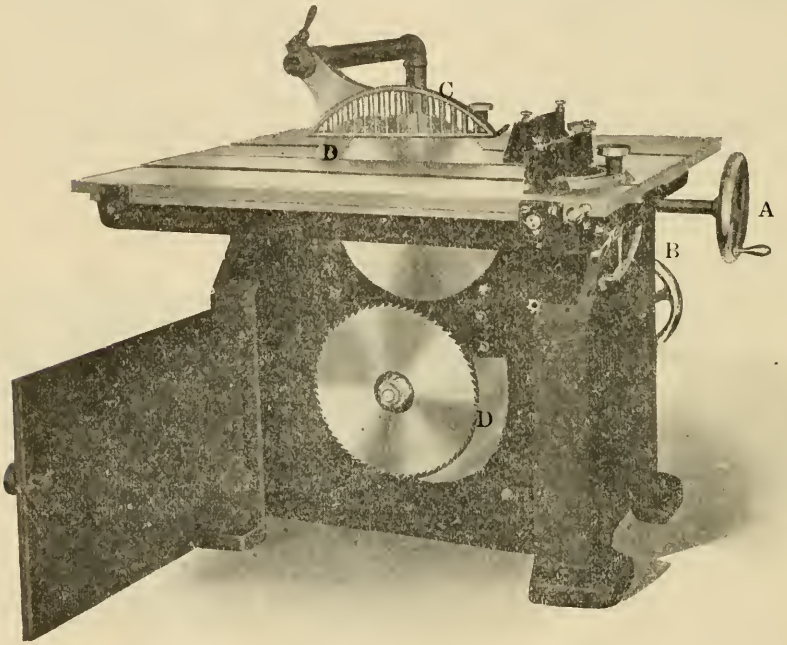


FIG. 12—DOUBLE ARBOR SAW WITH GUARD and SPLITTERS

the Double Arbor or Universal Saw Table, Fig.13. (it also has a horizontal mortising attachment in this case).

These machines are the most dangerous of all of the machines

usually found in school woodworking shops. They are probably not as dangerous as the Tenoner and the shaper, but these two machines are usually omitted in the school equipment, except in the highly specialized trade schools, because of the danger to the operator.

Before learning more about the circular saw you must come to a realization of the extreme necessity for the **implicit observance** of all instructions concerning the use and operation of these machines whether single or double arbor type.

The Universal saw, Fig. 12, has a hand wheel "A" for revolving the two saw arbors making it possible to change very quickly from rip to cross cut saw or vice versa, and for raising or lowering the saw which determines the distances it projects above the saw table while in use. Remember that the saw should **never project farther** above the table than is absolutely necessary for the thickness of stock being cut.

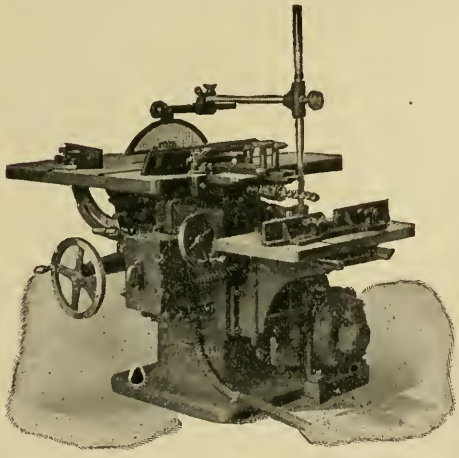


FIG. 13—SINGLE ARBOR SAW WITH GUARD AND MORTISER.

The guard "C" and splitter "D" also shown in Fig. 12 are necessary as "Safety Devices." The guard should be used at all times when possible. The splitter is a farther safeguard because it keeps the stock from pinching after it has passed the saw.

Another hand-wheel "B" is provided which makes it possible to tilt the table from its position to an angle of 45°. (Use the tilting index to get the desired angle). Always see that the clamp is set before using the saw. This holds true whether the table is tilted or level. The fence "E" in Fig. 14 may be tilted so as to cut a chamfer just as in the case of the jointer. The fence must never be moved

while the saw is in operation. The left side of the table is on rollers so that it can be run backward and forward, while sawing, by releasing a stop under the table.

The Single Arbor saw is like the Double Arbor in most respects, except that having only one arbor it is necessary to remove the nut on the arbor and change the blades when changing from rip sawing to cross cutting work. This nut is turned counter clock wise to tighten. Miter blades may be had which answer fairly well for both rip and cross cutting work but to do both successfully it is necessary to keep it well fitted at all times.

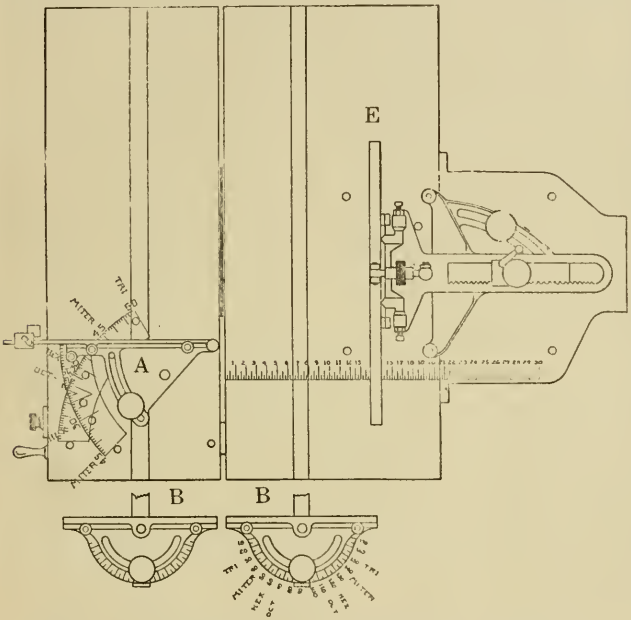


FIG. 14—TABLE AND GAUGE GRADUATIONS

18. Operation- Preparatory to ripping stock which is the simplest operation on the circular saw (1) make sure that you have the rip saw and that it projects through the table only as far as necessary for the stock which you are going to rip. (2) Make sure that the fence is adjusted for the proper width. Use the scale on the top of the table which is shown in Fig. 11 for adjusting the fence. When you have it approximately adjusted tighten the clamp and then make the adjustment exact by means of

the micrometer adjustment. Notice the locating holes in the top of the table for adjusting the fence to cut very wide stock. (3) See that the clamp on the tilting hand wheel, "B" in Fig. 12 is set, and if you are using the Double Arbor Saw be sure that the clamp under the table is set so that the top will not roll. (4) Last but not least see that the guard and splitter are in place. You are now ready to shove the stock over the saw. When the end of the board starts over the saw make sure that the edge is against the fence and you will have no difficulty in ripping parallel with the edge and getting the exact width of stock for which the fence has been set. As you push the board over the saw, stand either to the right or to the left of it. Should the board twist in any way and become caught in the saw you could not stop it or get out of the way in time to prevent a serious accident. When the stock is narrow, or it becomes necessary for your hands to come near the saw use a push stick as shown in Fig. 7, while operating the jointer.

When cutting stock to length the miter cut-off gauge "A" in Fig. 14 is used. This gauge has a groove into which a stop rod is fixed and on the end of which is a stop, as shown on the miter gauge in this figure. Not only is it possible to cut stock to length and at the same square the ends, but by using the adjustments indicated it is possible to cut for triangles, miters, hexagons, octagons, etc. In using the miter gauge place the stock against the stop and gauge, after you have adjusted the rolling side of the table so that it will move with the stock while cutting to length. It will readily be seen that a miter gauge cannot be used in this manner with the single arbor saw table which does not have the sliding top. To do similar work on a plain saw table the universal miter gauges shown at "B" in Fig. 14 are used. They slide in grooves in the table top and may be used on either side of the saw. Strips of steel are provided for filling these grooves when the universal miter gauges are not being used. This is necessary since the grooves would otherwise fill with sawdust and hinder the operator in pushing the stock over the table.

In using the ripping fence as a stop for cutting stock to

length be sure to attach the metal clearance block to the fence which is provided for this purpose. Some machines do not have them, in which event a block of wood should be used and held in position by means of a wooden clamp.

19. Cutting Tenons-- The saw table may also be used for cutting tenons when making mortise and tenon joints. The cut-off guide or the universal gauge is used for this and set as for a square cut. If the universal saw is used, the rolling section should be released. Attach the clearance block to the ripping fence. If attaching to a plain saw table which does not have a clearance block a block of wood may be clamped in place, using a wood or iron clamp. Then set the fence so as to cut a tenon of the proper length (remember that saw kerf must be justified when reading graduation). Raise the cross-cut saw so that the saw will project just enough above the table to cut the depth of the shoulder required for the tenon. Then clamp the shaft so that the saw will not drop. Before begining to saw make sure that your rails have been cut to proper lengths. The saw may be reset for cutting the shoulders on the edge of the stock if necessary. The best practice is not to cut shoulders on both ends as just explained but to remove the fence and use the stop rod on the cut-off guide. For the end of the tenon which has had shoulders cut against the stop on the stop-rod and then the tenon at the other end, will insure having exactly the same length between shoulders. After the shoulders have been cut the rip saw is used to cut the cheeks. Raise the saw so that it will just cut into the kerfs made by the cross-cut saw. Set the fence so that when the cheeks have been ripped from each side that the tenon will be of the thickness already determined by the saw kerf made while cutting the shoulders. You may cut both cheeks of the tenon at the same time by using two saws with steel washers between them to allow thickness of the tenon. Remember that in cutting a 1-2" tenon you will have to separate the saws more than half an inch or abont one-sixteenth more than the thickness you desire to saw, due to the set in the saws.

20. Speed And Power.--Saws from 10" to 16" are in general use on saw tables. The 12" size is probably used more than any other. Motors from 5 to 7 1-2 horse power are used, depending on the size of the saw and the thickness of the stock to be cut. A 12" saw should be run at the rate of 2850 R. P. M., while the 16" saw being larger would only require a speed of about 2200 R. P. M. As a general rule it may be stated that the circular saw should be run at a speed which will give it a surface or cutting speed of about 9,500' per minute. If run too slowly, power is wasted, the saw does poor work, gets out of order more quickly, etc. On the other hand, if run at too high a speed, and particularly if the saw is dull, it will cause it to heat and buckle.

A good method for installation of individual motor drive is shown in Fig. 15. If a single arbor saw is used it will be necessary to provide a belt tightener or use a sliding base on the motor. A careful study of the solid and dotted lines will show you the guard.

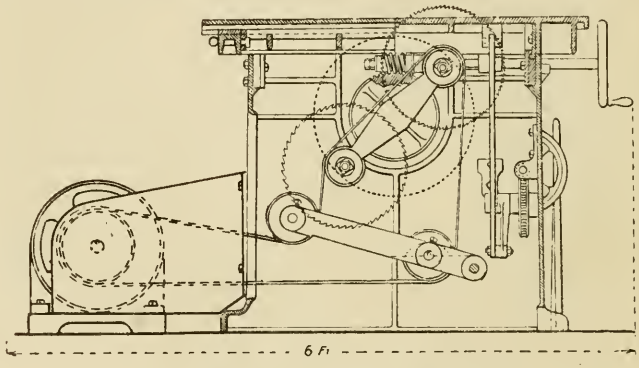


FIG. 15--MOTOR DRIVE GUARDED

21. Dado Heads

Dado Heads are the tools used in connection with the saw-table for the purpose of cutting grooves "**with the grain of the wood**" and dadoes "**across the grain of the wood**". Fig 16 shows the head completely assembled as it appears when placed on the saw-mandrel. To understand just how it is put in place you are referred to Fig. 17, where one outside cutter has been placed on the Mandrel and several of the center cutters, (also called fillers), have been put in place.

The dado heads come in different sets and may be made to cut grooves from 1-8″ to 4″ in width. However, if used in school shops it rarely happens that a width wider than one inch is needed. A set No. 4 will cut grooves 1-8″ to 1″ width by sixteenths. The outside cutters are both 1-8″ in thickness and may be used singly or as a pair to cut the 1-4″ groove. To adjust for the different width grooves place the outside cutter (also called groover) on the arbor and then add the inside cutters of the necessary thickness to give you the proper width to cut after the other outside cutter has been placed on the mandrel.

FIG. 16 DADO HEAD READY FOR OPERATION

Just as much care should be exercised in using the dado heads as is exercised while using the circular saw. While it is a safe tool for the careful worker who follows instructions, it is dangerous for the careless operator.

FIG. 17 ILLUSTRATING PARTS of DADO HEAD

22. Points Always to be Observed While Operating the Saw Table.

1. Do not cross-cut without using the miter cut-off gauge or the universal miter gauge.

2. Always use a clearance block on the fence when using it as a stop while cross-cutting.

3. Have the saw only as far above the table as necessary for the stock which is to be cut.

4. Always have stops on the fence or table when making cuts which do not go through the stock and are shorter than the full length of the stock.

5. Do not adjust the fence while the saw is in motion.

6. When ripping stock, be sure that the edge is held firmly against the fence as it first starts over the saw, and keep it there.

7. Do not stand back of the piece as it passes over the saw (if thrown back it will injure you seriously) but keep to the right or the left of it.

8. Make sure the hand wheel and fence are clamped before starting the saw.

9. If the saw binds while ripping, lift the end of the piece so that it comes clear of the saw. [This will be easy if the saw is not set too high.]

10. Use a push stick when ripping narrow or short stock.

11. Do not pick up pieces from the table when the saw is in motion, use a stick to push or rake it off.

12. Do not use a dull saw, it is both costly and dangerous.

13. Make sure that the guard and splitter are in place before starting the saw.

14. Stop the saw when you leave to do an errand in another part of the shop, or, while you use another machine.

15. Always drop the saw below the table top when leaving the saw.

23. **Fitting Circular Saws** --No matter how the saw is made nor how good the steel from which it is forged, it will not work in a satisfactory manner unless it is at all times properly set and sharpened. Not only will a saw in poor condition do poor work, but is very dangerous to the operator. As a general rule, the distinction between a poor mechanic and a good mechanic can be discovered at once by the condition in which he keeps his tools. The poor mechanic uses dull tools, while a good mechanic always has his tools in first class condition.

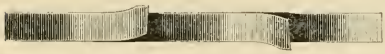


FIG. 18—BRIAR DRESS CIRCULAR SAW.

FIG. 19—SWAGE TYPE CIRCULAR SAW.

Rip saws are fitted in two ways. One, spring set briar dress, as illustrated in Fig. 18, the other, swage type, as illustrated in Fig. 19. As a rule, all shops use both types of saw. The swage set saw

requires more power since it has a greater capacity (one tooth practically doing the work of two of the spring set type). As already stated, either of these types will do good and satisfactory work when properly fitted.

24. **Fitting the Rip Saw With Swage Set**-- The first step in fitting the saw is to joint it. By jointing we mean to get the saw perfectly round so that the teeth are all of an even length. This should be done with the trade mark up on the saw. Proceed by placing a piece of grinding stone, emery wheel, or an oil stone that is no longer used for sharpening purposes, against the saw while the saw is revolved at a moderate speed (saw should project slightly above the table while jointing). This method of jointing of course is not necessary when a sharpening machine is used.

After the saw has been jointed, the teeth are all filed to a keen point, being careful to file just to the marks left by the stone in jointing so that all of the teeth will be of the same length, and the same shape, otherwise they will not swage properly.

Until you have had a great deal of experience, it will be necessary to use a gauge in filing the teeth to shape after jointing as illustrated in Fig. 20, in order to get all of them of the same shape. The gauges are to be had for the asking from certain manufacterers of saws, and are included with the saw swage when it is purchased. Use a 10″ mill file with round edge so as to keep the gullets round (see art. 29 for files).

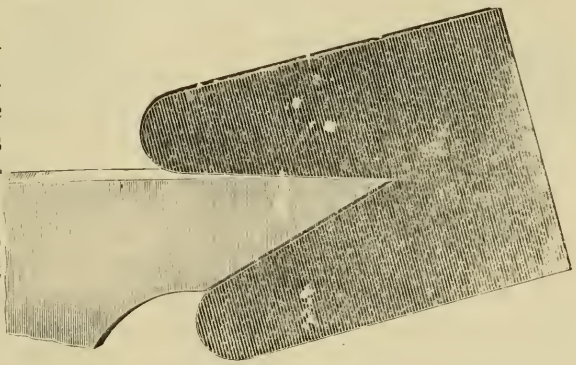


FIG. 20 -GAUGE FOR REGULATING THE SHAPE OF TEETH.

After the saw has been properly filed it is swaged so as to give the teeth clearance when they enter the wood. If they do not

have proper clearance they dull very quickly and also heat, which causes the saw to lose its temper. Some type of saw swage, one of which is shown in Fig. 21, is used for this swaging or upsetting. When examining the swage it will be seen that one side is convex and that the other side is straight. The convex side is used for upsetting the teeth "H" in Fig 21, and then it is straightened with the other side "G" also shown in Fig. 21.

FIG. 21— SAW SWAGE

Be sure that the swage is held in such a manner that the angle of the teeth is not changed. Also, it should be held so as to drive from the front under side. This is necessary in order to give it the proper "rake". If a saw is always given the necessary rake in swaging, the diameter is not reduced as rapidly. If, on the other hand, the swage brings pressure to bear from the top side, it causes it to decrease in diameter much more rapidly. Hold the swage at the same angle for all of the teeth, so as to avoid getting it out of round.

After swaging, the saw is again jointed as it was in the beginning then filed so that all of the teeth are brought to a sharp point. Be sure that you file at right angles to the side of the saw. If you fail to do this, the saw will not run properly. If it is filed at an angle it will lead in and out of the stock according to the direction of the angle. This, of course, will make it impossible to do good parallel ripping, and will soon put the saw out of commission.

Next, dress the sides of the teeth the same as when you are filing hand saws. This may be done by placing the saw on the arbor and holding a stone with a right angle end on the table and against the side, while revolving it slowly by hand. There are tools for this, called side files that may be used instead of this improvised devise if they are available. A good type is illustrated in Fig. 22. The file is adjusted for the proper width by means of the set screws B. Af-

ter locking these, the tool is held by means of the clips at "A". The points of the three set screws must at all times be kept against the blade.

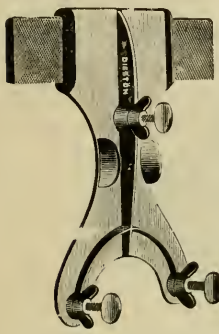


FIG. 22—SIDE FILE

25. To Fit The Rip Saw With Briar Dress. --To fit a briar-dress (Fig. 18) rip saw, you proceed the same as in the case of the swaged tooth saw, with the exception that the points of the teeth are bent alternately instead of being swaged, as stated in the operation just described.

To set the teeth, use a set as illustrated in Fig. 23. The anvil is set so that its edge will strike the tooth about 1-4" from the point. By means of the screw gauge the desired angle of set is obtained. Use a No. 3 saw set for circular and cross cut saws from 14 to 20 gauge. To get the best results, as little set as is absolutely necessary is given. This causes less waste since it decreases the amount of sawdust made while sawing.

Some prefer an adjustable setting stake for this work. A good type is shown in Fig. 24. It may be adjusted to set saws from six

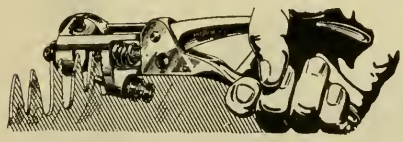


FIG. 23— HAND SAW SETFOR CIRCULAR AND CROSS-CUT SAW

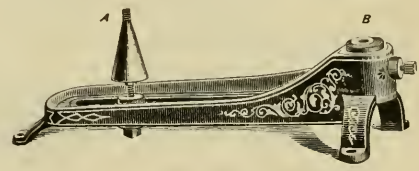


FIG .24— ADJUSTABLE SETTING STAKE FOR CIRCULAR AND CROSS-CUT SAWS.

to thirty inches in diameter, by moving the cone "A" in or out to fit the saw. Certain portions of the face side of the hardened steel anvil "B" are beveled more than others so that by adjusting it and raising or lowering the cone "A" any desired set can be obtained.

26. Gumming--In order to understand what is meant by a properly

gummed saw, refer to Fig. 25. The circular gullet below point "C" shows a gullet which has been properly fitted. If the gullet is filed square as at "A" and "B", especially if the teeth are dull, the saw

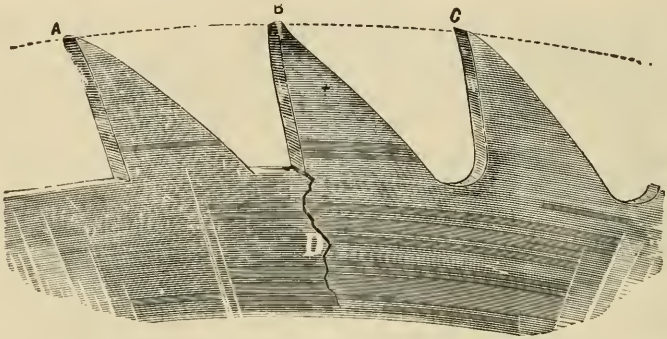


FIG. 25— CORRECT GUMMING AND THE RESULT OF SQUARE GULLETS

dust accummulating in the square gullet will cause the saw to crack as at "D".

Experienced saw fitters tell us that the round file is the proper tool for gumming a saw. However, in modern practice the emery gummer, Fig. 26, has taken the place of the hand-file. This attachment may be purchased with certain grinders, or may readily be made in any blacksmith shop for a grinder that does not have this attachment. A free cutting wheel should be used, and little pressure applied at all times. This is done to avoid heating

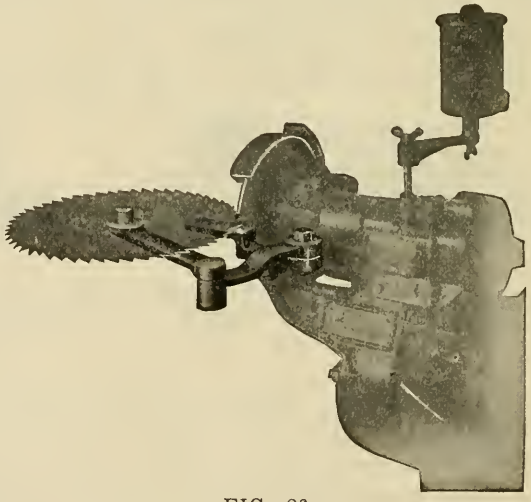


FIG. 26—
GUMMING ATTACHMENT FOR GRINDER

of the teeth. If they become blued or case hardened by the emery wheel they are liable to break.

In gumming, go around the saw a number of times, instead of attempting to finish each tooth at one operation. Not only is a more uniform gullet obtained in this manner, but you are much less liable to overheat the teeth. The emery wheel (or composition stone) should be jointed frequently so as to remove the glaze and retain the proper face. Before gumming on the emery wheel, study "Saw Gumming" in the chapter on grinders.

27. Fitting Cut-off Saws-- Cut-off saws are set in the same manner as the briar-dress rip saw. In fact, they are fitted in the same manner, except that the teeth are given more bevel both front and back. The proper shape of the tooth for soft woods is shown in Fig. 27, the proper shape for hard wood in Fig. 28. When gullets are cut as illustrated in Figs. 27 and 28 they require frequent gumming. Fig. 29 shows one tooth filed with gullets that have been properly gummed. A saw filed in this manner is liable to breakage the same as indicated at "D" in Fig. 25. The type of tooth shown in Fig. 30 and designated as under cut, does not require as frequent gumming as the old type of cut-off saw. The cut-off saw, as in the case of the rip saw, requires frequent filing.

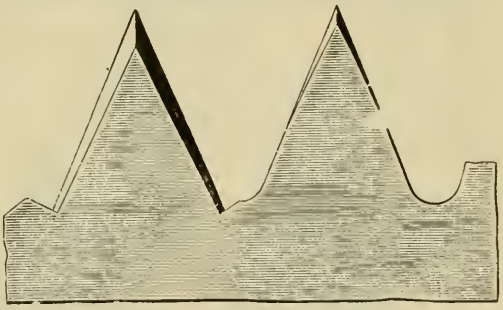


FIG. 29 COMPARISON OF CORRECT AND INCORRECT GUMMING.

28. ECONOMY IN SAWS --A good, deep, full cut instead of a light, scraping one means a saving of of both time and files when sharpening saws. The depth of cut taken at each revolution of the saw determines the distance on the face of the tooth which is dulled, for example, each tooth cutting 1-30", requires 30 teeth to cut 1"

while if each tooth cuts 1-15", only 15 teeth will be required to cut the 1". In other words the fiber of the grain of the lumber must be broken 30 times in one case, but only 15 in the other. The tooth breaking the fiber 1-15" will do it with nearly as much ease and with about the same power as when breaking 1-30". This example illus-

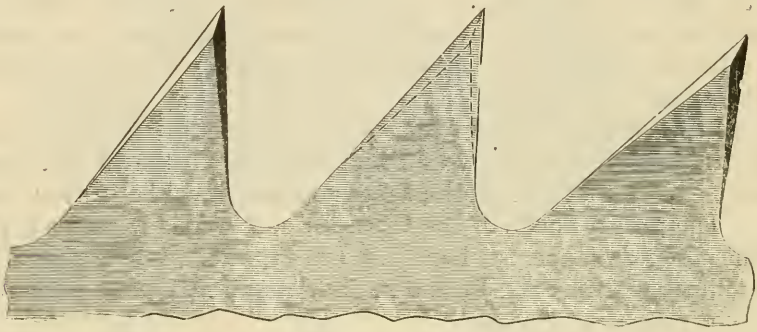


Fig. 27— FOR SOFT WOOD

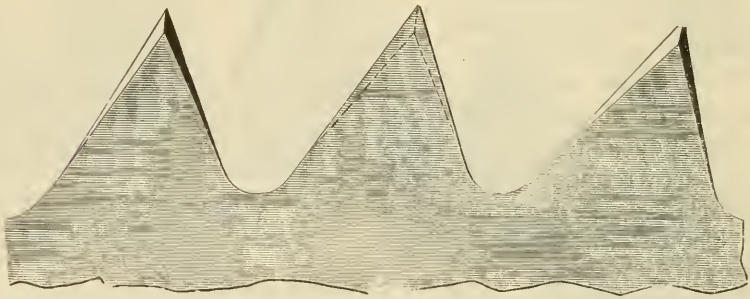


Fig. 28— FOR HARD WOOD

trates that one tooth becomes dull 1-15" under the point while the other becomes dull for 1-30", but it must be noted that it requires practically the same amount of saw-plate, file and time in either case

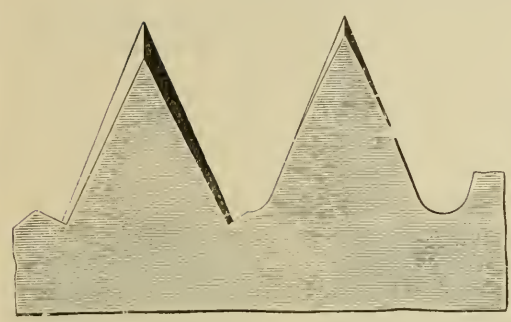


Fig. 29—RIGHT AND WRONG GUMMING

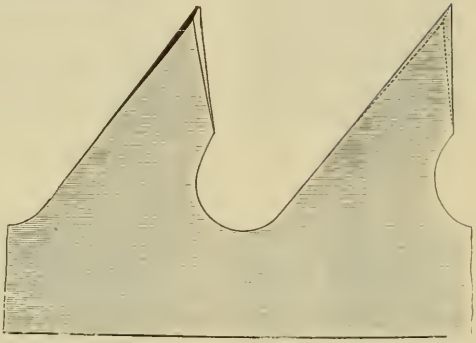


Fig. 30—
UNDER CUT TOOTH
(Does not require
frequent gumming)

(strike a happy medium and do not go to extremes). On the tooth in Fig. 31, AA are the original lines of the tooth, dotted line B shows where the point first wears; dotted line CCC shows how it should be filed back on the periphery line; but, too frequently, on account of the long surface to be filed, operators file the top only as represented by the dotted line D. It is readily seen that by filing back on the dotted line CCC the saw has been reduced in diameter only from dotted line E to F, while filing from the top of the tooth the reduction will be shown by dotted line from E to D.

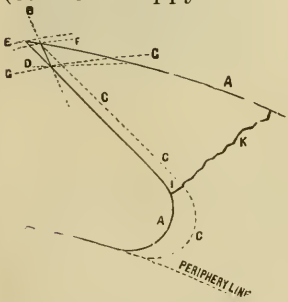


Fig. 31—FILING BACK ON THE PERIPHERY LINE

Thus we see that by filing on top five times as much of the saw has been wasted as by proper filing. This difficulty is overcome by the use of the gullet tooth as shown in Fig. 30 and Fig. 32 which outlines both the straight tooth and the gullet tooth. Using the gullet tooth leav o excuse for filing on top. To hold the saw while filing use an adjustable circular saw-filing vise, or make a wooden one in the shop.

Fig. 32- COMPARISON OF OLD AND GULLET STYLE TOOTH

29. False Economy-- It is false economy to endeavor to save time by not filing often. One authority says: *"Many hours' time have been wasted and many saws ruined through the false economy of not sharpening often enough. We have never seen a saw mill where it is not true economy to sharpen saws from two to four times in a full day's sawing. A saw properly swaged or set, will stand from two to five filings before it needs re-swaging or re-setting."

For average work (part hard and part soft woods) it is a safe rule to file once for every three hours of sawing.

30. Files-- No tool is used for as many different purposes and has as many different kinds and styles as the file. Not only are there several hundred different kinds of regular files but several thousands of regular and special files combined, all of which are designated by name according to the length, shape and grade of cut. Those in ordinary use are flat, mill, hand, square, round, half-round, taper, and slim-taper. Most files are now made by machine although journeymen still exist who cut even the finest files by hand.

By noticing the fineness and the narrowness of the teeth of the dead-smooth file it will be realized how much skill is required in cutting these fine teeth, often barely visible to the naked eye. Fig. 33 illustrates the different cuts of files in common use. These illustrations are engraved from files 12" long, consequently if the the file which you use is longer than 12", the cuts will be coarser,

* Disston, Handbook on Saws.

if shorter they will be finer in proportion.

The single-cut files, which are shown in the illustrations have but one course of chisels cut across the surface, which are parallel to each other or oblique across the file blank. The double-cut file has, as shown in Fig. 33, two courses of chisels cut across each other. The first course is called the over-cut and the second course is called the

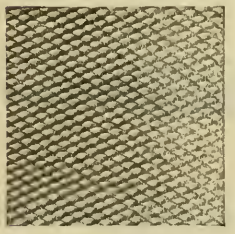
Sections of Single Cut Files

Bastard

Second Cut

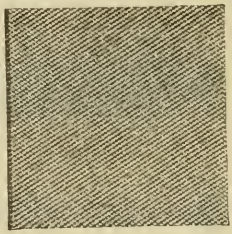
Smooth

Sections of Double Cut Files



Bastard

Second Cut

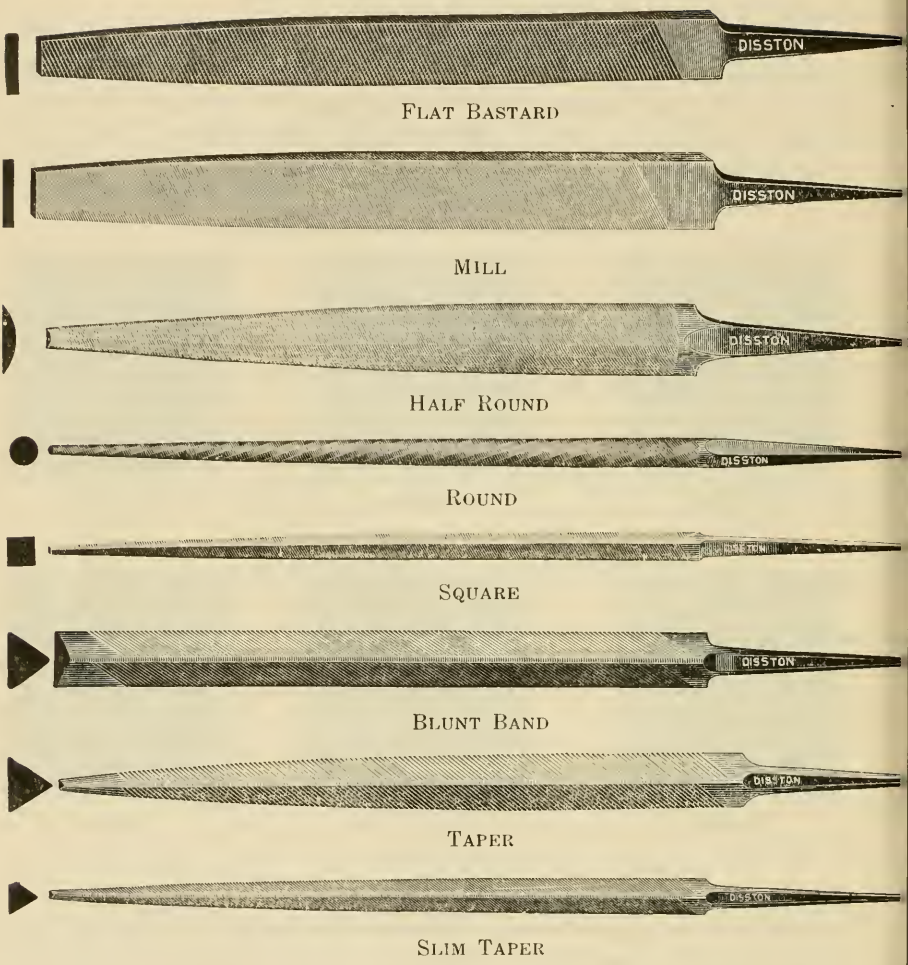


Smooth

FIG. 33

up-cut. This results in leaving fine points as compared with the chisels on the single-cut file. The terms bastard-cut, second-cut and smooth-cut, as printed in Fig. 33 mean coarser or finer cut files, or, having more or less teeth to the inch. A rough-cut file is coarser than those shown in the illustration and the dead-smooth is a finer file.

Files are made in various sizes and shapes as already stated. Those in more common use have already been named and are illus-



FLAT BASTARD

MILL

HALF ROUND

ROUND

SQUARE

BLUNT BAND

TAPER

SLIM TAPER

trated in Fig. 34. The flat files taper from near the center to the point, are narrower and slimmer at the point, are double-cut on the sides and single cut on the edges. These are used for coarse and rough work.

Mill files are forged similar to the flat files. Some have one and others two round edges. They are used for filing saws, knives and and other high grade work; having chisel teeth they leave a smoother surface than does the one with double-cut teeth.

The round files are single-cut and are usually forged tapering though some are of uniform size from heel to point.

Taper files are made of three cornered steel and usually taper, being smaller than the other three-square files (not shown in the figure) are single-cut and have teeth on edge as well as on sides, but not cut quite to the point. They are made blunt and are used for filing band saws and all small saws. Some tapers are made longer than others from the same size steel and are called slim taper. The advantage of this file is that it gives a greater length of stroke in filing.

Some tapers are forged tapering at both ends instead of having a tang at one end for handle, thus making two files in one.

CHAPTER V

THE PLANER OR SINGLE SURFACER

The single surfacer, also called planer, shown in Fig. 35 is of a

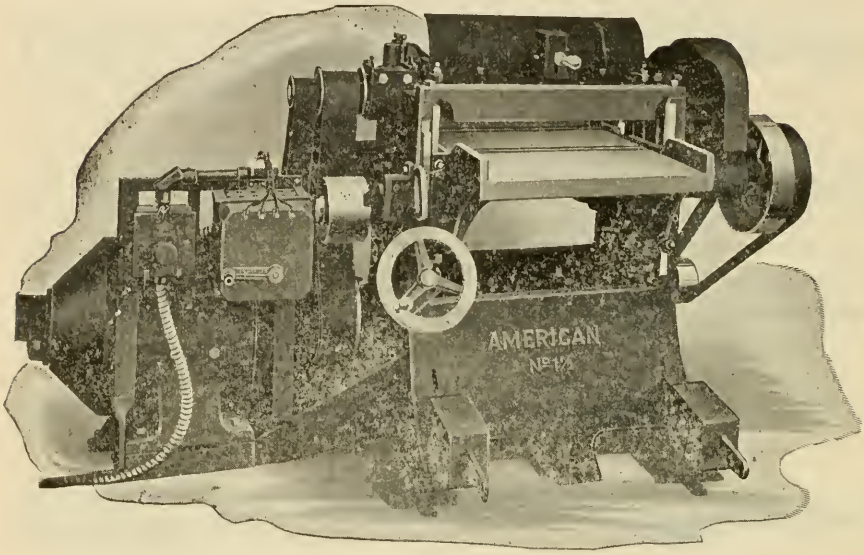


FIG 35—SINGLE SURFACER WITH INDIVIDUAL MOTOR DRIVE AND ENCLOSED SWITCH AND RHEOSTAT.

double belted type. By this is meant that power is transmitted to the cylinder, or cutter head, on each end instead of driving it from only one end as in the case of the jointer which is single belted. (Some cheap makes of single surfacer are single belted.) The cylinder is similiar to that of the jointer except that the square cylinder is still being used to a considerable extent. However, the better class mills and shops are beginning to use the cylindrical type entirely. Upon the sides of the planer it will be seen that the belts and gears which drive the feed rolls, are entirely separated from the cylinder drive. The hand lever, just above the hand wheel on the left of the machine,

as you stand on the side from which the stock is fed, controls the feed. The fast revolving cylinder cannot be stopped suddenly even if the power is cut off, but by loosening the lever the feed roll may be stopped at once. This is a safety in case of accident, and when too heavy a cut is being taken, loosening the lever enables the motor to pull through without blowing a fuse. After cylinder gains speed again the lever is tightened so as to again start the rolls, though it will usually be necessary to lighten the cut. The smoothness of the cut depends on the speed to which the feed rollers are adjusted. In the cheaper makes of machines only one speed is possible. As a rule this is about 24' per minute, but on better grades of machines it is possible to adjust for a speed 16' to 32' per minute. Special high speed machines run soft woods as fast as 75' per minute. Planers vary in width from twenty to forty inches and special machines have greater width than this. The machines usually found in school shops have a capacity for planing stock up to 6" or 7" in thickness and 24" wide but some machines have a capacity for planing stock considerably thicker. If the machine is a good one and is properly adjusted, it will plane stock as thin as 1-16". Some surfacers plane both sides at one operation and are known as double surfacers, while still other machines surface four sides at one operation. If the rheostat is not near the machine, the electrical installation should include a single wire with switch for throwing out the rheostat without leaving the planer. It may be opened and closed in one operation; this throws out the rheostat, but leaves it ready for starting.

32. Use--After jointing the face side of a board, the surfacer is the machine which planes the stock to the thickness. As explained in the introductory chapter, the machines are described in the order of use as far as possible. The ordinary procedure is (1) to cut to length on the swing saw as explained in Chapter II, (2) to make working face and edge on jointer Chapter III, (3) rip to width on saw table, Chapter IV, and (4) plane to thickness on planer as described here when it will be ready to square to length and then model.

This machine will not plane material out of wind, as is sometimes

thought by beginners. To do good work the face side should be planed on the jointer before cutting it to thickness. However, when surfacing stock for ordinary work, or material that does not have any wind in it, both sides may be planed on the surfacer.

33. **Operation and Adjustment**--The hand wheel, just below the gauge on the left side of the machine in Fig. 35 is used to raise and lower the table so as to adjust it for the wood which is to be planed. Find the thickest part of the piece which is to be planed and set it so as to take a cut of about one-sixteenth of an inch in thickness. It is sometimes necessary to raise the back end of the board slightly higher than the top of the table in order that the corrugated feed roll may grab it and draw it into the machine. Feed so that the cylinder will cut with the grain. It next passes under the chip-breaker pressure bar which is adjusted either by a spring or weight (weight in this case.) After passing the pressure bar it now meets the cylinder head and the chips follow the curve of the breaker and fly out over the machine. Just after the board passes under the cylinder head it encounters the back pressure bar which holds it firmly to the bottom feed rollers so that the stock is cut to a uniform thickness. After the back pressure bar the stock of course passes between the two feed rollers to the back of the machine and continues on through.

When planing a number of pieces always run the thickest ones through first taking off about a sixteenth of an inch at a time.

It is a good plan to have brushes under the bottom feed roller in order to keep the shavings and other matter from sticking to them which results in marring the stock. Ordinary scrub brushes may be used and can be secured in some improvised manner so that the bristles remain firmly against the rollers.

Considerable care and practice is necessary in adjusting the surfacer. The feed rollers do not require adjustment if they have been properly adjusted at the factory, except as they have become worn. The bottom feed roller must project only as far above the table as is absolutely necessary to carry the stock. Adjust the corrugated roller so that it has just pressure enough to move the stock. The corrugated

roller and the smooth feed roller on the back of the machine are both adjusted with special reference to knives. The top roller in the back should have as little pressure as necessary to move the stock.

Adjustment of the planer knives is the most difficult part and may be done by placing parallel blocks on the table under the cylinder. It requires considerable experience to do this with accuracy and dispatch. The best class of modern planers have the grinding attachments on them which makes it unnecessary to remove the knives except as they wear out. Several manufactures have portable grinding devices which make it possible to grind and adjust both planer and jointer knives without removing them from the heads. This, of course, effects a great saving of time. See index for cut and description of portable grinding device.

When feeding the stock through the planer do not get behind the moving stock since it happens that the stock is thrown back and would result in injury to the operator. Keep to either side of it.

Never plane short pieces. When feeding several pieces through at the same time be sure that you put them in straight and allow sufficient space between so that they will not interfere with each other while passing between the feed rollers.

34. Speed and Power--The cylinder speed of a single surfacer should be from 4200 to 5000 R. P. M. From 4 to 7½ H. P. motors is required to operate this machine depending on the size and the kind of stock to be cut. Generally speaking if the machine is not over 24" in width a 5 H. P. motor is ample.

35. Points always to be Remembered

1. Remember what has been said about the feed — that it can be stopped instantly by loosening the feed lever.
2. Do not leave the machine running when you are through using it, or while going on an errand before you continue.
3. Do not plane pieces less than one foot in length.
4. Never plane two pieces that are against each other— leave a space between them if two pieces are being put through at one time.

5. See that this machine, as well as any other that you use, is properly oiled at all times.

6. In starting the motor, be sure that the planer is at its maximum speed before you throw over from the starting point.

7. If there is a shaving exhaust, be sure that the hood is in place and the fan is started as you begin work.

8. To set for thickness, drop the table lower than required and raise it back to the desired thickness. Also, see that the feed weights are properly set before beginning to feed the machine.

9. Feed so that the knives will cut with the grain.

10. Do not feed the material into the planer in such a way that the ends of the boards will strike or catch in the guides at the edges of the bed.

11. Have the lumber ready before starting your machine and be sure you know the thickness to which you are going to plane.

12. As much as possible should be planed at one setting of the planer. This not only saves time but insures even thickness. Here is seen the reason for planing the poorest side of the board first.

13. Do not do all of the cutting at one place on the knives when narrow work is being planed. Distribute it equally throughout the length of the knives so that they will wear down and dull evenly.

14. In running through very long boards, a roller horse the height of the table should be placed at the proper distances back from the planer. If such a horse is not availible and you have only a few such boards to plane, hold the back end up.

15. For very accurate work, test a trial piece by measuring with a ruler.

16. In planing wide pieces that are to be ripped later, always rip them before planing if the boards are warped.

17. Warped lumber cannot be straightened on the planer. It is useless to attempt it. Take it to the jointer.

18. In planing lumber s2s that has not had a face jointed on it, most of the stock should be removed from the poorest side. Do this first since you do not know how far down the poor place on the stock ex-

tends, being careful, however, to leave enough to take one cut on the other side so as to leave it smooth.

19. Do not walk on lumber after it has been piled.

20. Boards should not be dropped heavily on the floor.

21. Exercise judgment in the depth of the cut to be taken. Remember it is easier on the machine to go through once taking 1 16" cuts than it is to force it through taking 1 8" cuts.

22. Remember that if the planer begins to slacken speed or to check, the feed may be stopped by means of the hand lever and so left until the cylinder gets up speed again.

22. Comparison of the Planer and the Jointer-- (a) The planer smooths, but does not make a true face on warped stock as the jointer does. (b) The jointer cuts away equal to the amount at which it is set while the planer leaves stock equal to the amount at which it is set. (c) The jointer will smooth the second face but does not leave it parallel with the first. The planer does.

CHAPTER VI

BAND SAWS: HOW TO OPERATE, SHARPEN, ETC.

36. General -- Band saws are made in right and left hand types, the right hand being more universal. Figs. 36 and 39 show right hand machines which are properly guarded. Instead of the wire door as the top some machines have a wooden frame of panel construction. The bottom guard in this case consists of two cast iron doors. Sometimes the lower guard is made of panel doors, or, wire frames similar to the guard on the top of the wheel. The guide post, shown at "A" in Fig. 36 is a very essential part of the machine. The Mohawk Dutchman saw guide which is attached to this guide post is shown on a larger scale in Fig. 37. The guides on either sides of the blades should be set quite close to the saw. The wheel, "B", on which the back of the saw runs,

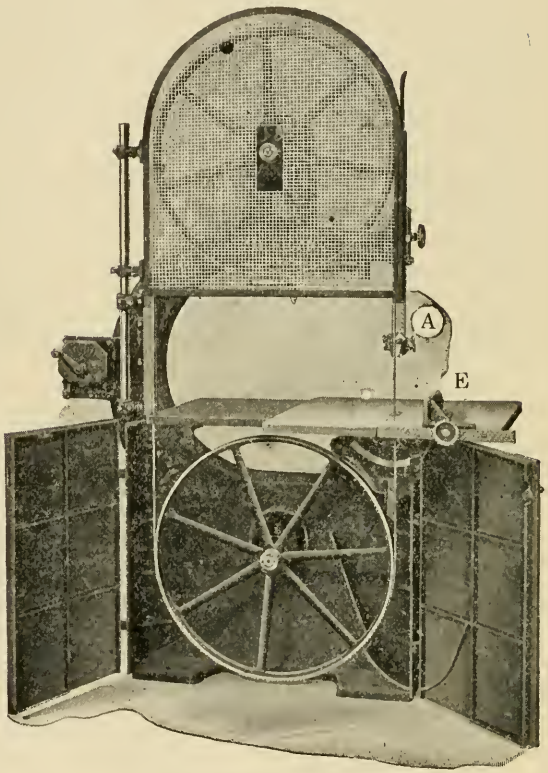


FIG. 36 — BAND SAWS "A" GUIDE POST "E" RIPPING FENCE

should be set so that the teeth just clear the two guides.

The top wheel of the band saw is adjustable and can be raised or lowered by means of the handwheel at "C" in Fig. 38, to accomodate the different sizes of saws.

The small adjusting wheel at "D" is for tilting the wheel so that the saw will not run off when you start the machine.

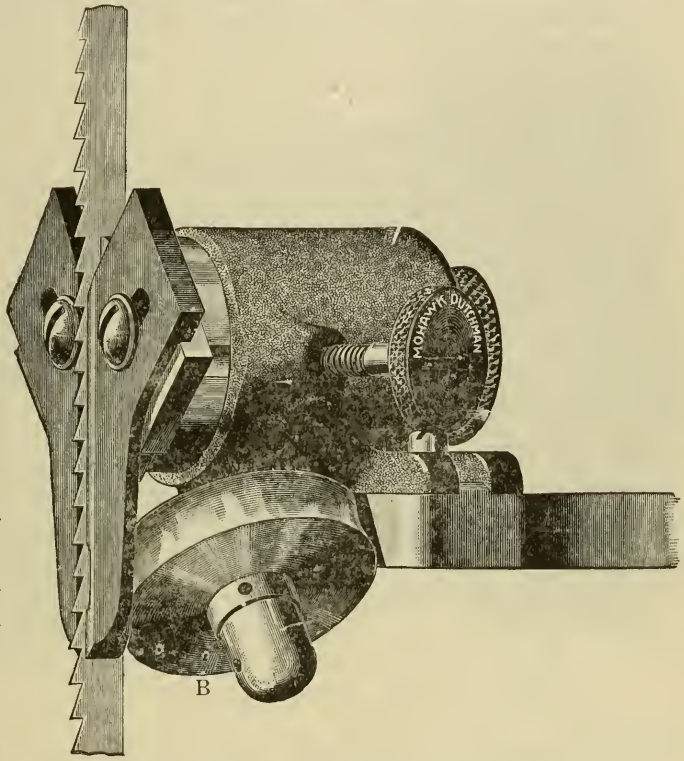


FIG. 37—MOHAWK DUTCHMAN SAW GUIDE.

When using thin stock, it involves considerable waste to plane down inch boards to, say, $\frac{1}{4}$" to $\frac{3}{8}$" in thickness. By means of a re-sawing attachment, it is possible to split the boards without much loss of material. A good type of re-sawing attachment which can be put on the band saw is shown in Fig. 39. This saw feeds at the rate of about 12' per minute. Most band saws also have a tilting table with micrometer adjustment and accurate graduation.

37. Use--Up to the present time the machines described have been

necessary to square up stock to a certain definite dimension. In making projects where the construction is very simple, or when the stock is ready to assemble after squaring, no modeling is required.

The band saw is one of the machines which is used in modeling, that is, cutting to certain patterns such as rockers for chairs, and other form work. The sander, mortising machine, boring machine, etc., are for modeling and finishing.

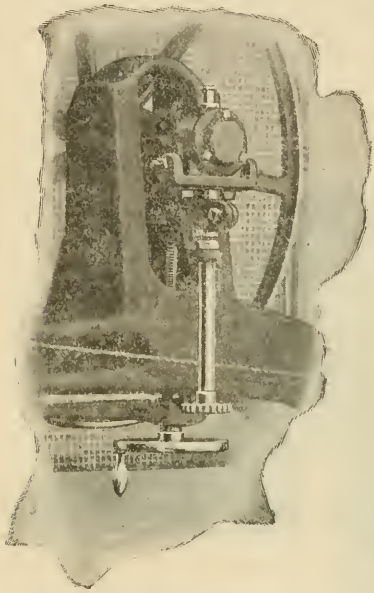


FIG 38. — TENSION AND TILTING

There are times when the band saw is used in ripping to width. For work of this kind, a fence such as is shown at "E" in Fig. 36 is necessary. Ripping to width on a band saw is not accurate, however, like ripping on the saw table.

38. Operation-- The guide "A" in Fig. 36 should be kept as low as possible at all times, when operating the band saw. When sawing, keep in front of the saw and do not step around in line with the direction of travel of the saw wheel. Should the saw break, there is no danger if the machine is properly guarded, and you remain at the operator's station.

Always use as heavy a blade as is possible for the work at hand. If, when making sharp turns, the saw is not able to make the curve which you desire, or you keep backing up the blade, it is either too wide or it doesn't have enough set. It is considered by experts to be a better practice to cut out rather than back out if you find that you cannot make the curve which you are attempting, by means of the cut already started. There are cases however, when it is necessary to back out in order to keep from spoiling a piece of work. When

this happens it is best to stop the machine and get the instructor to inform you as to the best method of freeing the piece of stock.

Just before you throw in the power, if the machine which you use is an individual motor drive, it is well to start the saw by whirling the wheel, this helps the motor gain headway without undue strain (the other machines we have studied do not require this). If on a

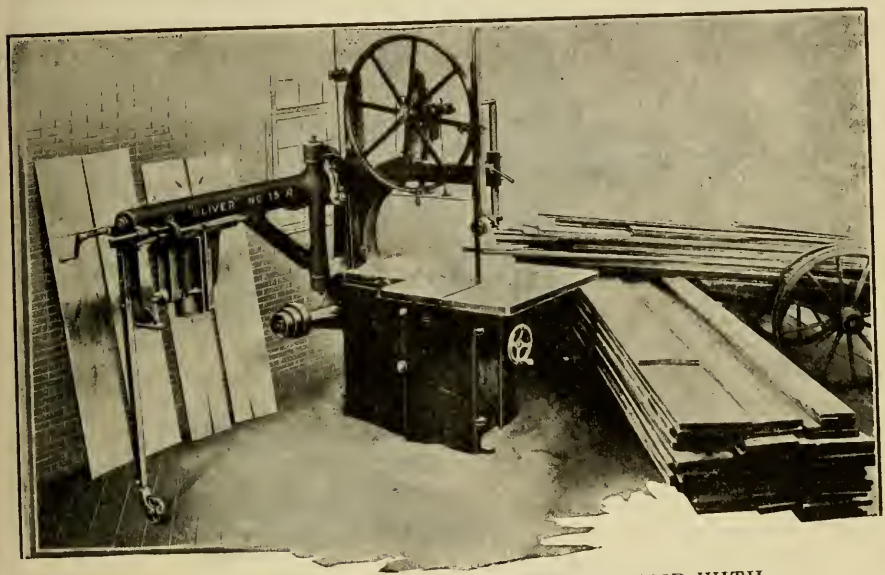


FIG 39 BAND SAW PROPERLY GUARDED AND WITH RE-SAWING ATTACHMENT

line shaft, shift the belt slowly and let the saw get a start before you give it the full width of the belt.

39. Speed and Power-- Ordinary work require a 3 H. P. motor. This power should be transmitted to the drive shaft either by means of belt or chain since the direct drive machines do not seem to prove as universally satisfactory.

The speed of the drive wheel should be as follows: for 30" saw 650 R. P. M., 32" saw 600 R. P. M., 34" saw 550 R.P.M., and

36" saw 500 R. P. M.

40. How To Care For Band Saws--Good judgment must be exercised in breaking in a new band saw if it is to give long and efficient service. A new saw will not do as much work as one that has been perfectly adjusted and adapted to the wheels. A new band saw seems to be unusually elastic, and until it has been used for a short time, it does not seem to get its proper bearings.

It should not run more than a half-hour without stopping, for the

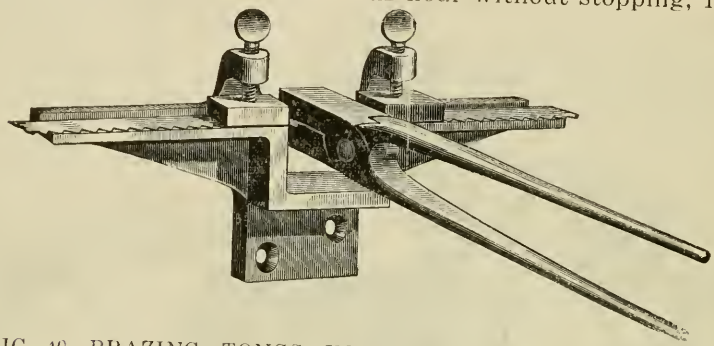


FIG. 40—BRAZING TONGS IN POSITION AFTER HEATING

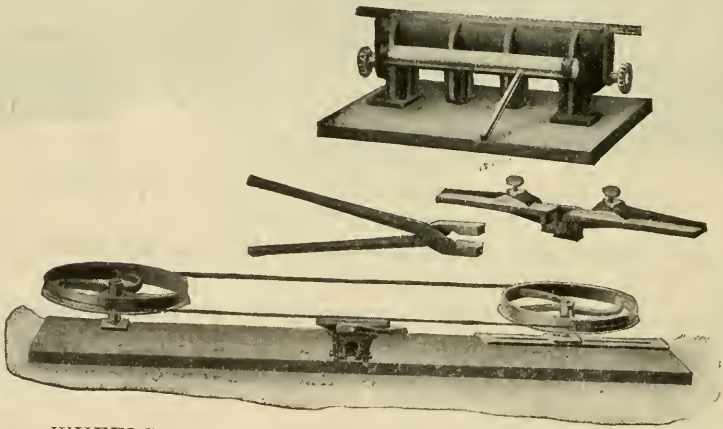


Fig 41 — WHEELS AND CLAMP FOR HAND FILING. (LARGER SCALE VIEW OF CLAMP AND BRAZING TONGS AT TOP.)

first few times that it is used, and above all, be sure to release the tension when the saw is no longer in use. This is particularly essential while breaking in a new saw, but should be observed at all times, if the maximum efficiency and endurance is desired.

41. Why They Break-- Breakage is caused in several ways, but only the more conspicuous ones will be mentioned. If a saw is used with too heavy a tension, it is bound to break. Sometimes in "heavy duty" work the tension is made stronger after the saw becomes warm and expands. Then, if this tension is not reduced after the saw is stopped, it is bound to break when the saw cools and contracts.

Saws used when dull, not only do unsatisfactory work but soon crystallize and break with the least unusual strain. It is very poor policy and a dangerous procedure to use saws when dull.

The operator should remain in his position in front of the saw, so that if the saw does break, he will not be in a position to suffer accident. Do not use the machine unless it is properly guarded.

Another reason for breaking saws is guides not properly set or constructed. The guide shown in Fig. 37, the Mohawk Dutchman Type, eliminates to a great extent, the possibility of cracking and crystallization, and consequently lengthens the life of the saw. The wheel forming the back guide has a concave surface on its periphery. In addition to this, the wheel is set at an angle so that the back of the saw passes diagonally across the point of periphery of the wheel which causes it to revolve. With the point of bearing constantly changing, it prevents the saw grooving the surface of the wheel.

Both wooden and steel guides are provided for the sides of the saw. The saw will give much better service if these wooden guides are used at all times. In the same way, the guide just below the table on the saw, should have wooden guides not only on the side of the blades, but back of the saw as well. If these have not been provided they can readily be made and attached in the shop.

42 Brazing -- A brazing clamp with tongs is illustrated in Figs. 40 and 41. Before joining, the ends must be filed at an angle so as to give a good bevel fit to the ends. (Be sure that the joint after

brazing will be no thicker than any other part of the saw.) Both ends of the saw are then secured in the clamp, as shown in Fig. 40. The edges must be parallel, that is, the back edges of the two ends of the saw must form a straight line, otherwise the saw will run badly and break soon after it has again been placed on the machine. This may be kept straight, if the back edge of the saw is placed firmly against the straight edge which forms the back part of the clamp.

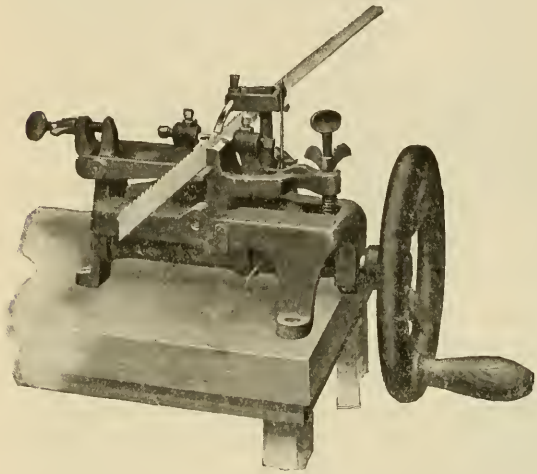


Fig. 42.—NARROW BAND SAW SETTING MACHINE

For a flux, use a thin coating of borax paste. This is prepared by grinding the borax on a specially prepared slate, with a small amount of water. A thin piece of sheet silver solder, just the size of the joint, is then placed in the lap. The brazing tongs heated to a bright red, are next placed over the joint, as shown in Fig. 40. However, be sure that you first scrape the scale off between the jaws of the tongs. An old file or similar tool may be used for this.

The joint is then held with hot tongs until the solder has throughly melted. If a second pair is at hand it is well to follow this up with another pair of tongs that have been heated to a dull red. This helps to set the solder and prevents it from chilling too rapidly. A carriage clamp or similar iron clamp may be screwed on the jaws to hold them in place while taking care of the second pair of tongs, if it is to be used. If the joint is too thick after brazing, dress it to the thickness of the saw.

43. Setting and Filing-- When small band saws are set by hand the process is very much like that of setting and filing an ordinary cross-cut hand saw. But to do this conveniently, it is necessary to have two large wheels (either wood or metal) and a vise, Fig. 41, on which to hold the band saw while fitting. The more common method however, is to use a machine for setting and an automatic machine for filing. A narrow band saw setting machine is illustrated in Fig. 42. This machine sets all of the teeth uniformly and may be adjusted to set saws $\frac{1}{8}$" to $1\frac{1}{2}$" in width with the teeth spaced 1-16"to $\frac{5}{8}$". The vise automatically grips the blade while the teeth are being set and prevents in this way the twisting of narrow saws.

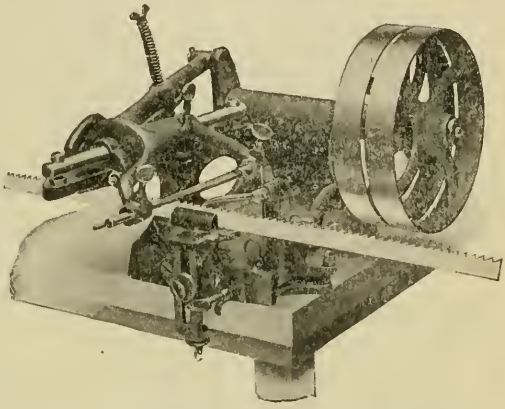


FIG.43 AUTOMATIC FILING MACHINE

This machine should run 100 revolutions per minute which enables the operator to get a new saw in about 5 minutes. The automatic filing machine is shown in Fig. 43.

This machine is intended for a power drive or may be arranged to drive by hand. It will take saws of the same specifications as the setting machine in Fig. 42.

Old saws with uneven teeth may be filed to exactly the same height and made as good as new. This gives more satisfactory results than when the saws are filed by hand. This machine uses 6 " taper saw files, and should be run at the rate of 50 to 60 revolutions per minutes.

Fig. 44 shows a combined filng and setting machine and is operated as follows:

Placing the Saw in the Machine

*"1. Remove the file before placing the saw in the machine. To do

*From Instruction Sheet of Wardwell Mfg. Co.

this, turn thumb screw E and draw the file out through the socket holder.

2. Loosen the butterfly nut H which allows the vise jaw to open, also see that I is loosened enough to allow the saw to pass in between the setting points. Now place the saw in the vise and tighten H and I sufficient to allow the saw to be pulled through by hand, but not so loose as to chatter when being filed.

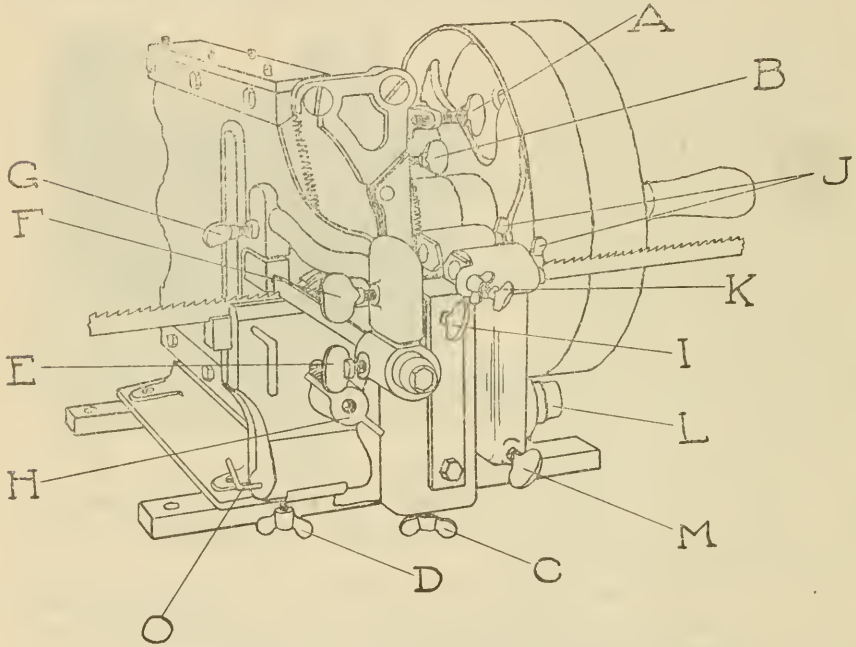


Fig 44 — BAND SAW FILING AND SETTING MACHINE

3. The back edge of the saw should rest on the supports D and C by which it can be raised or lowered in the vise.

Have the entire tooth show slightly above the top of the vise under the file but only partly above in the vise where the tooth is set.

4. Loosen the two pair of setter screws J and K so that the setter point will not be in action while adjusting the file.

Adjusting the File and the Pawl

5. Replace the file and before tightening E, turn the drive wheel of the machine partly around by hand so as to allow the file to come down aud rest between the teeth, by so doing you can see at what angle the file should be tightened in the holder. Then tighten E.

F and G allow the file to be raised or lowered a trifle whenever necessary. G should always hold the tang of the file a fraction higher than the point of the file is held by F. By a little attention to this point, the teeth can be filed obsolutely free from any burr. E when loose allows the file to be turned to present a new face and F and G are used as adjustments for files of various thickness.

A Seven Inch Slim Tapered File is Preferable

When using a 4½ in. extra slim taper file for fine teeth, change the cam roller screw to the inner hole in the cam. Keep the file that comes in the machine as a sample to buy other files. We recommend any good quality of file. The support holding the tang of the file, as well as the bushing in the end of the sash arm, are both reversible to accommodate different size of tangs or points.

6. Thumb screw A regulates the length of the stroke of the pawl or feed finger; adjust this screw so as to allow the pawl to come back just one tooth and push that tooth ahead under the file.

This is easily accomplished by moving by hand the drive wheel back and forth, but not at any time completely around, by so doing one can observe that both the file and pawl are working correctly.

7. Thumb screw B is to regulate the pawl so that it will not come in contact with the file. Should the file touch the pawl or feed finger, turn B until it clears. This screw also regulates the amount of cut required to be made on the face of the tooth.

Adjusting the Setting Attachment

8. By loosening screw M the setting attachment can be slid along sleeve L so as to bring the setter points in direct line with the saw tooth. This should be done when the file is resting in the tooth and the pawl is traveling back. When in a line, tighten M. Loosen the two wing nuts J and adjust the two thumb screws K which regulate the amount of set desired, then tighten the wing nuts J. and in so doing see that the setter points or dies travel close along the top of the vise.

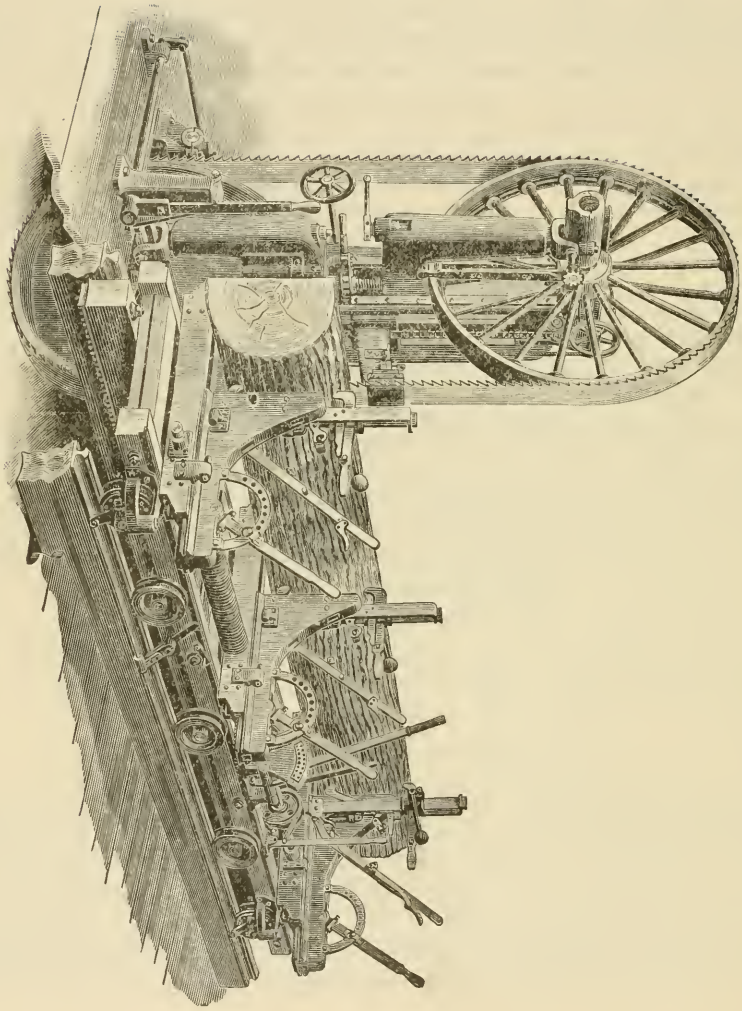


FIG. 44 A—BAND SAW MILL.

Now turn the drive wheel around slowly one complete revolution. See that the setter points set the teeth on the same side that they were previously set, this will avoid breaking the teeth. Operate the machine by hand for a dozen or more revolutions, watching the setter point set the teeth. If your saw is an old one with irregular teeth, run it through the machine a couple of times so as to even up the teeth before attempting to set them.

Keep the machine well oiled. Operate not over 65 revolutions per minute, slower is better for the file. Occasionally pull out O and clean the vise of any fine dust that may have worked into it. If the driving cam and slides are kept well oiled the machine will last for many years."

44. Large Band Saws--The band saw is used in preference to the circular saw in large mills. The circular machine is used in the small portable outfits. A right hand band saw mill is shown in Fig. 44 A.

CHAPTER VII.

MORTISING MACHINES

45. General-- In general mortising machines are divided into two groups — vertical and horizontal and are a monument to the progress since the time when mortises were made by burning with a red hot iron. The vertical type Figs. 45 & 46 is the more logical since the stock is placed on a table and the bit enters the wood instead of having the wood forced onto the bit as is the case with most types of horizontal mortisers such as are in general use in schools in connection with the saw table is shown in Fig. 12.

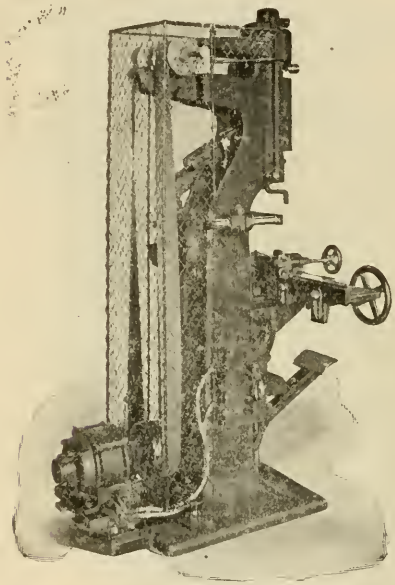


FIG. 45 VERTICAL HOLLOW CHISEL MORTISING MACHINE
(BELTS PROPERLY GUARDED.)

The hollow chisel bits, Figs. 47 & 48, are used in this machine.

When first placed on the market it was referred to as the machine "that bores a square hole" and has been named the hollow chisel mortising machine. The square chisel just referred to Figs. 47 and 48, has a special form of bit to bore all inside of it and runs at a high rate of speed. The bit runs slightly ahead of the chisel which forms the square hole, for in reality the chisel is obliged to cut the corners and the chips are carried away by the bit. The different machines have different adjustments for the table and since no one explanation would be sufficient for all machines, this, for the

most part is left to your instructor.

46. **Operation--** In setting up the for mortising, exercise care in selecting the proper bushings. Make sure that the set screw passes through the bushing and that it rests on the flat side of the bit, and **above all,** make sure that the bit is slightly ahead of the chisel.

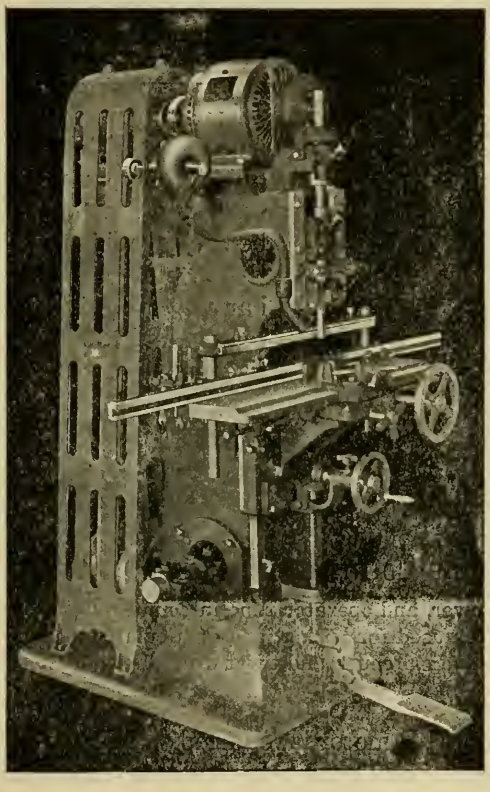


Fig. 46:- Automatic Vertical Mortiser; Motor D. C. Connection, enclosed switch and rheostat.

Then push the foot pedal to the floor and hold it there while adjusting the table so as to cut a mortise of the proper depth. Adjust the stops and fence and you are ready for operation.

Some machines are equipped with a clamp or compound table. This differs. from the plain table in that the table moves back and forth. The table may be tilted to the right and to the left. The angle to which it may be tllted is from 30° to 45°.

Hollow chisel bits are made in various sizes such as $\frac{1}{4}$", $\frac{3}{8}$", $\frac{1}{2}$", $\frac{5}{8}$", $\frac{3}{4}$", $\frac{7}{8}$", 1", etc. But taking more cuts the $\frac{3}{8}$" bit will make a mortise larger than $\frac{3}{8}$". For example $\frac{1}{2}$" mortise

FIG. 47 HOLLOW CHISEL WITH BIT.

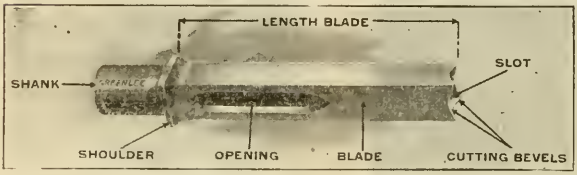


FIG. 48. HOLLOW CHISEL WITHOUT BIT.

can be cut with this same bit and will require four cuts instead of one as would be the case if using the $\frac{1}{2}$" bit. In a similar way the $\frac{3}{8}$" bit readily makes a mortise $\frac{3}{4}$" x $1\frac{1}{2}$", etc.

Fig. 49— EXTENSION LIP COUNTER-SINK BIT

(This saves 50 percent of time, power, and operator time in counter-sink boring. The mortising machines are often used for boring, and particularly the horizontal type. In this connection a universal chuck and twist drill bits may also be used to advantage.)

47. **Speed and Power--** A 2 to 3 H P.motor is required. The counter shaft should be run at a speed of 900 rpm. which will give the bit a speed of 3500 to 4000 rpm. Fig. 46 shows a D.C. motor connection with enclosed switch and rheostat. When ordering machines which are to have a motor base, it is necessary that the manufacturer be informed in regard to the make of motor which is to be used.

CHAPTER VIII.

WOOD TURNING LATHE.

48. General-- There are several different forms of wood turning lathes in use. Some have an overhead drive and run from a counter shaft. Others have a motor head where the lathe in Fig. 50 has a cone pulley. The other type, and the one most used is the one shown in Fig. 50, and is called an under-drive. These lathes are also built in different sizes. The size is determined by the largest diameter of the stock which it will turn, and the longest length which can be turned between centers.

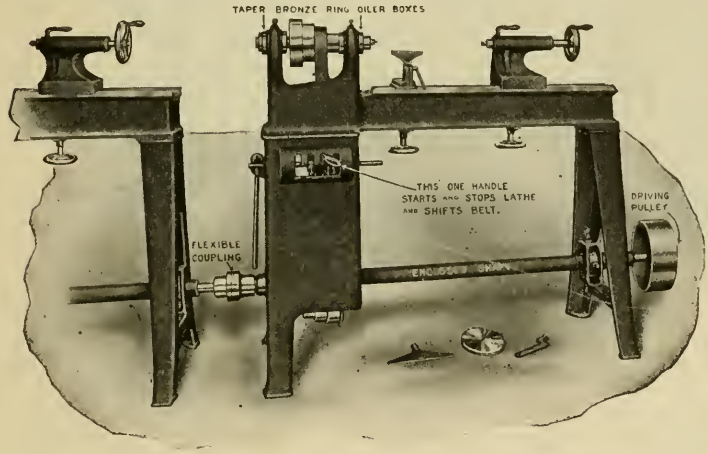


Fig. 50—UNDER-DRIVE TYPE OF WOOD-TURNING LATHE.

The stock is secured in the live center which is held in the head stock spindle. This is also called the spur center.

The tail spindle which is adjustable contains the dead or cup center which keeps the stock in place.

49. Use-- The wood turning lathe is used to turn pieces to cylindrical form. In addition to this, all kinds of variations developed from regular coves and beads are possible. Space does not permit a detailed description of the care and operation of this machine. However, it may be stated that the best results are obtained when printed

instructions, supplemented by demonstrations on the part of the instructor are used.

50. Speed and Power-- ¾ H. P. is necessary when an individual motor drive is used on the average medium size lathe as found in school shops. As already stated in article 48, the under-drive type is more economical. While a ¾ H. P. motor is necessary for an individual drive in order to meet maximum conditions, a 3 H. P. is quite ample to drive a line of six or eight lathes with individual control. It is readily seen that in a group of six or eight lathes only a few will be doing heavy duty work, since most of the work attempted in school shops is of a small diameter. The drive shaft referred to may be noted in Fig. 50, and is inside of the casing marked "enclosed shaft." The drive shaft and pulley should be of such a diameter as to give a spindle speed of from 700 to 3000 R. P. M. In the case of the machine represented in Fig. 50, the speed of the drive shaft should be approximately 600 R. P. M.

CHAPTER IX.

SANDERS.

51. General-- Sanders are used to smooth the surface after planing so as to prepare it for stain, varnish, or any other kind of finish. The different sanders are belt, disk, spindle, drum, or a combination of these.

52. Belt Sander-- A typical style of belt sander is shown in Fig. 51.

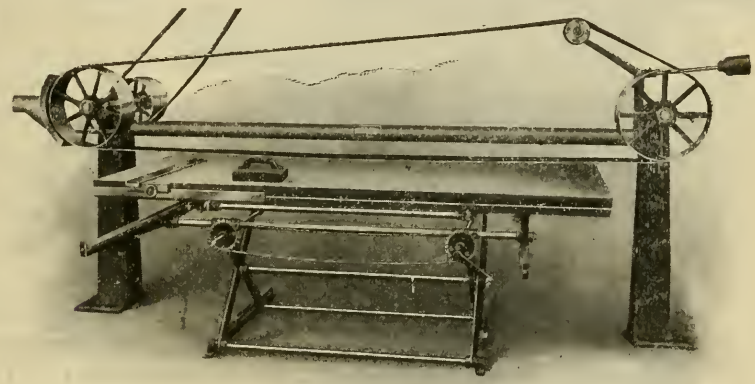


Fig. 51—BELT SANDER

The pulleys at either end supporting the sand belt may be placed any distance apart, determined, of course, by the length of table which is used. The idler pulley at the top makes it possible to push the belt down on the work, which has been placed on the table, by means of the hand block shown on the table in the figure just referred to. Some sanders have an idler at either end. The table is adjusted vertically, and moves from front to back in order to sand the entire surface of pieces placed on the table.

Canvas sand belts are used for this purpose, although it sometimes happens that paper sand belts are substituted but are not as satisfactory as the canvas belts. These belts are bought in rolls, and are glued together in proper lengths. A piece of canvas may be placed

on the cloth side and glued and clamped similar to the manner in which a leather belt is glued. Another method is to remove the sand from five or six inches of canvas, and use this as a lap in gluing.

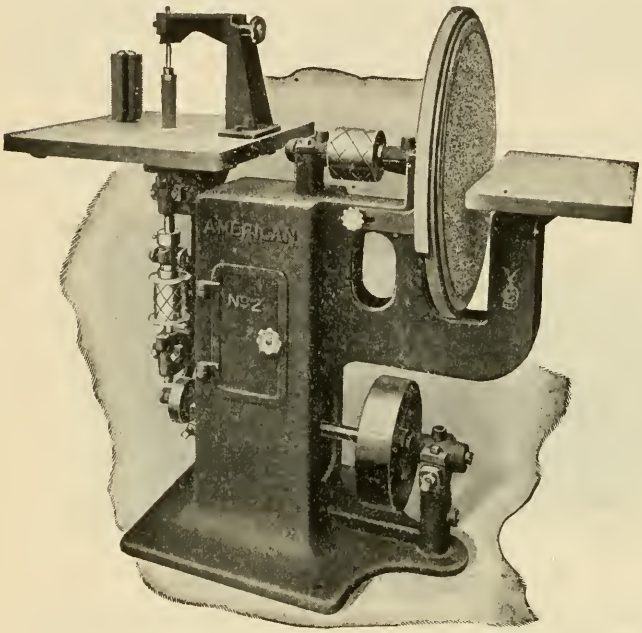


Fig. 52—DISC AND SPINDLE SANDER

53. Disk and Spindle Sanders-- The disk and spindle sander illustrated in Fig. 52 is one of the safest types in use. The disk, made of glued up strips, is covered with a piece of heavy Brussels, and acts as a pad for the sand paper. The iron band around it holds the paper in place.

The vertical spindle is for shaping curved work, and usually has two or three different sized spindles in order to make possible a variety of work.

It has an oscillating vertical movement which makes it possible to use the entire surface of the sand paper, and does smoother work.

54. Speed and Power-- Belt sanders, as described in Fig. 52, are run at a surface speed of about 2200 feet per minute, and require a 2 H. P. motor. The disk and spindle sander, described in article 53, should have a speed of 700 r. p. m. for disk, and 1200 r. p. m. for the spindle. A 2 H. P. motor is required for power.

The large drum sanders used in furniture factories having three to four drums 12" in diameter should run at the rate of 800 r.p.m., and require from 5 to 15 H.P.

CHAPTER X.

GRINDERS AND GRINDING

55. General--Until within the last few years, most of the grinding in wood working shops was done on grindstones, where a sandstone wheel was used as the cutting agent. This was a much slower process then the present oilstone grinder. It is still insisted by some that the grindstone gives better results. However, it is a fact that all progressive shops and factories are adopting the oil stone grinders for sharpening edge tools. The grinder in Fig. 53 is one of the several efficient types of this kind of machine now on the market.

Fig. 53 – COMBINATION GRINDER.

56. Drive and Speed.-- The machine may be driven from a line shaft as provided for in Fig. 53, but is usually equipped with an individual motor, one horse power being all that is required for this machine. The upper arbor should run at a speed of 1650 r. p. m., the oilstone wheels at 230 r. p. m.

57. Oilstone Wheels and Oil-- The wheels used are made of a special composition that is adapted to the grinding of edge tools when run in oil. The composition is so proportioned as to give the greatest possible abrasive qualities along with slow wearing features. The stone absorbs the oil which penetrates to the interior when the

wheels are not in motion, but when driven at the proper speed the centrifugal force forces the oil to the periphery. This is what keeps the stone clean and sharp since the oil coming from the interior lifts any gum or glazing from the surface. The machines are equipped with two stones, one for rapid cutting, and the other for putting on a smooth clean edge similar to that of an oilstone. However, it is always better to complete the honing of the tool by hand.

Fig. 54— AUTOMATIC KNIFE GRINDER

Kerosene oil is used on these machines and distributed evenly over the stone by means of the distributing devices into which the oil is dropped. Before the stones are used they should be thoroughly saturated with kerosene. After that little oil is required in grinding with the machine.

58. Tool Rest-- The tool rest table has a groove running parallel to the face of the stone. The tool holder with the tool is shown in Fig. 53, and operates back and forth in this groove.

59. Other Features -- The grinding cone is for all concave edges such as gouges, cutters, curved tools, etc. The leather wheel back of the cone is so arranged that the edge of the leather projects and permits of stropping of the inside bevel of gouges. Straight edge tools are stropped on the face. After the edge tools are ground they may be stropped to give the finishing touches. However, care must be exercised in using this stropping wheel and for the beginner it is advisable to use the bench oilstone and a hand strop.

The emery wheel on the back of the machine is used for general grinding purposes.

The wheels are protected by suitable guards and conform to the accident prevention laws.

60. Saw Gumming-- The attachment shown in Fig. 26 is necessary

when using the emery wheel on the back of the machine for saw gumming. A special wheel of the proper size for gumming is substi-

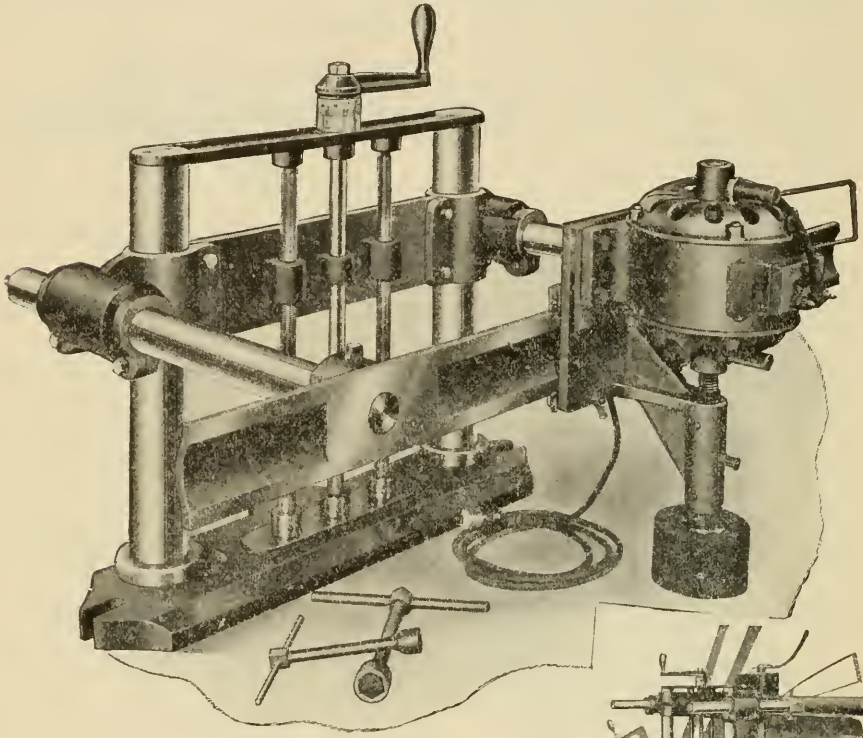


Fig. 55 — PORTABLE PLANER AND JOINTER KNIFE GRINDER

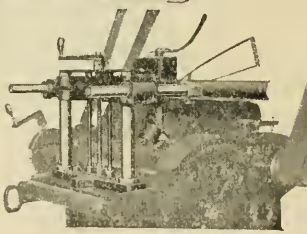
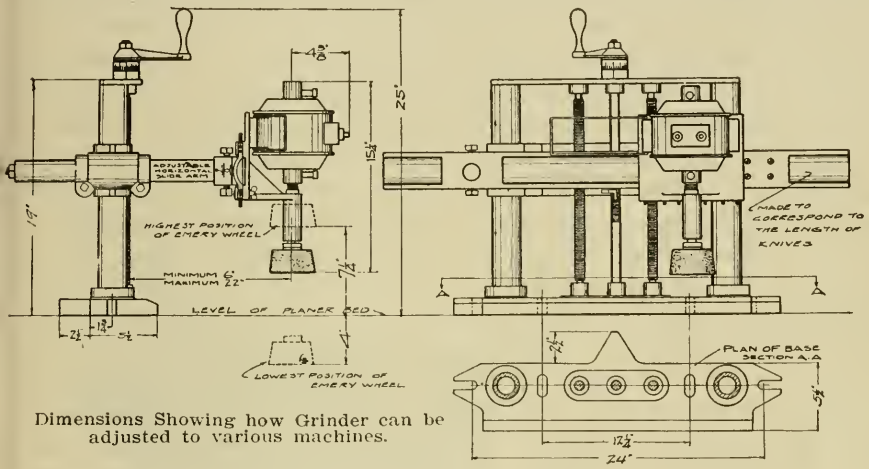


Fig. 56 — SHOWS FIG. 55 ATTACHED TO BED OF PLANER

tuted for the regular emery wheel. The rest has two attached rams so that one can be locked at any desired angle. Locking it at

a certain angle regulates the saw tooth; the second arm is pivotly mounted on the first and carries the saw to and from the wheel. This attachment may be used without interfering in any way with the other two wheels and the cone. When through gumming, this wheel should be removed and the regular emery wheel again put in its place.

61. Automatic Knife Grinding -- The tool rest table is loosened



Dimensions Showing how Grinder can be adjusted to various machines.

Fig. 57 LINE ETCHING OF ELECTRIE. PORTABLE, PLANER AND JOINTER KNIFE GRINDER.

readily and swung down out of the way so as to make room for the automtic knife grinding attachment, Fig. 54. With this it is possible to grind all planer and jointer knives. Only the coarse stone is used for grinding these knives. In adjusting for grinding, be sure the the knifes DOES NOT RUN OFF THE STONE AT EITHER END OF THE STROKE, but let it advance to within one - half inch of each end and then start the reverse stroke. To get the best results from the sufacer and jointer it is necessary that exactly the same amount of steel be removed from both blades when grinding them. In order to know whether or not they balance it is not well to guess at this but to use a knife balance which is just as sensative as that which is used by the druggist or in physical and chemical laboratories. After

grinding use a hand oilstone to put on the finishing touches.

62. Portable Planer and Joiner Knife Grinder.--The portable planer and jointer knife grinder in Fig. 55, makes it possible to grind knives on both circular and square cylinder heads in jointers and planer. The machine is attached by means of holes drilled and tapped in the base of the planer or jointers and is shown in Fig. 56. Also detail plan of the base section is shown in Fig. 57. The manufacturers of this machine urge that the knives be ground flat grind instead of hollow, suggesting at the same time that in using this machine the knife is held under the same strain while being sharpened as when in use, thereby eliminating the necessity of jointing after the machine has been taken from the clamp in the automatic floor grinder and again place in the cylinder head. The jointing of course, has a tendency to make a heavy heel which means more frequent grinding and consequently more wear and shorter life for the knife. However it should be stated that the casting which supports the motor is so constructed that it can be swung through a limited arc and locked in place so as to permit grinding on one edge of the cup wheel, giving a slight hollow grind as well as to have it in a verticral position, grinding square on both sides. It is also urged that in resharpening knives by this method, that they remain always in place and alignment. This, of course, makes the machine cut faster and smoother and reduces the operating power. The graduated scale on the lowering device and beneath the handle insures uniformity of depth in grinding to a thousandth of an inch. The grinding wheel spindle has a ball bearing thrust which relieves, through universal coupling, all pressure from the motor armature and through its special take up bushing permits a perfect reading of the micrometer scale. The slide bearing which carries the motor has an adjustment with a scale on it that opeates on the bearing on one end, being slightly raised or lowered. By means of this adjutment, the bar can always be in perfect alignment when the knievs are set further on one end of the head than on the other.

CHAPTER XI

TRIMMERS

63. General. Trimmers,-- Figs. 58 to 62, were invented primarily for the use of pattern makers and when used for other processes should be used only after you have learned to preform these operations thoroughly and quickly by hand. This machine, like the miter saw, should not be used by beginners in order to avoid learning to do the various process by hand. Always take very thin cuts when using this machine. When working soft wood $\frac{1}{8}$" cut may be taken and if hard wood is used, the cut should not be more than 1-16" in thickness. The machine must be kept sharp at all times if good results are to be obtained. The knives are very hard and in grinding should be ground with a very slight concave bevel. The back side must be kept perfectly straight.

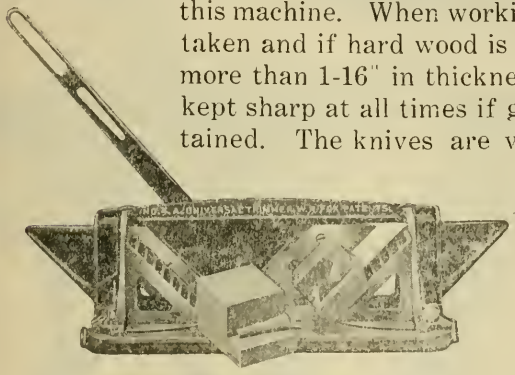


Fig. 58—TRIMMING INTO A CHECK

64. Operation-- One of the smaller bench type of trimmers is used to explain the operation and to show the possible range of work by means of auxiliary gauges which are furnished with most trimmers. Fig. 58 illustrates the trimming of a shoulder for either a half lap or a tenon. This is called trimming into a check. The gauge as well as the knife stands at an angle of 45 degrees, which makes it possible to trim down to the bottom leaving a square and smooth surface.

Fig 59 illustrates the trimming of a wide miter. The trimming of a narrow miter on a regular piece of material is not illustated; however, this is similar to that shown in Fig. 61. It is possible to miter a piece in this manner as wide as the machine will cut instead of simply as high as it will cut without the auxiliary gauge.

Fig. 60 illustrates the cutting of a compound angle. A hopper shaped figure can be cut in this manner. The number of degrees at which the regular gauge of the machine is set, swung away from 90 degrees, regulates the slope which the sides will have, while the auxiliary gauge causes the angle to be cut at a miter thus making a regular four sided figure.

Fig 59—TRIMMING A WIDE MITER

Fig. 61 shows a satisfactory method of trimming miters on crown or sprung moulding. A reverse pattern of the piece of moulding is first made 5" or 6" long and placed under the moulding while trimming. This pattern can be saved and used again. The auxiliary gauges used on the larger type of universal trimmer, Fig 62, permits of larger work and is therefore more valuble from the standpoint of utility.

65. Mechanical Aids—Fig. 63 shows the ingenious method in which the beds of some of the larger styles of trimmers are etched. The eccentric clamping lever makes it possible to locate the swing gauges at any desired angle. The prominent angles, of course, are located by means of the taper spring stop pins and taper holes in the bed.

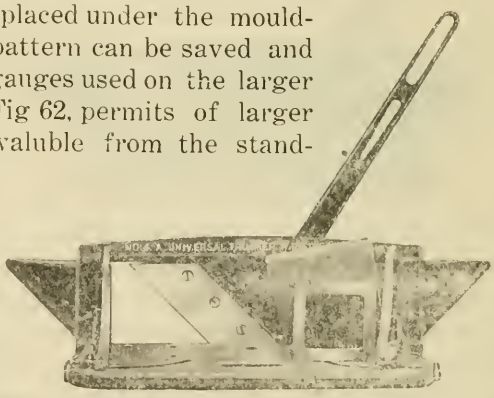
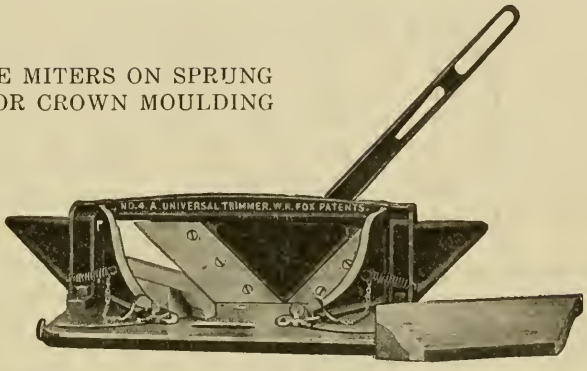


Fig 60—CUTTING A COMPOUND ANGLE

The bed is laid out for 3-4-6-etc. segments to the circle and for a wide range of diameters. The radiating lines show the different numbers

Fig. 61—OUTSIDE MITERS ON SPRUNG OR CROWN MOULDING



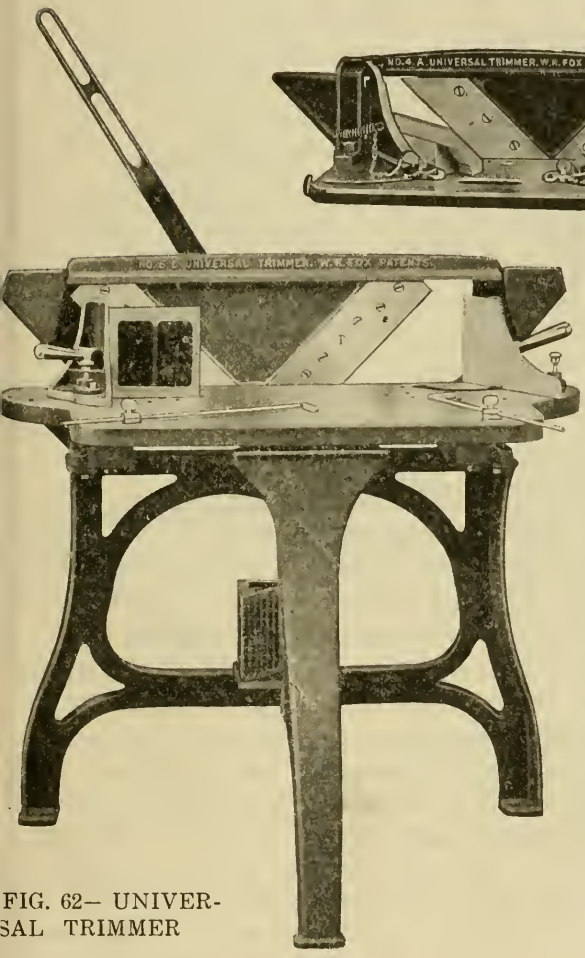


FIG. 62— UNIVERSAL TRIMMER

fosegm'ts while graduations on these radiating lines indicate the diameter which the complete circle will have when segments are trimmed to that graduation. This illustration also shows a patent stop rod for holding the segments in position for trimming. This is located at the desired graduation by fastening two thumb screws. The segment should be long enough to allow for trimming at both ends. Since the head is so arranged that it may bedrawn back a short distace by

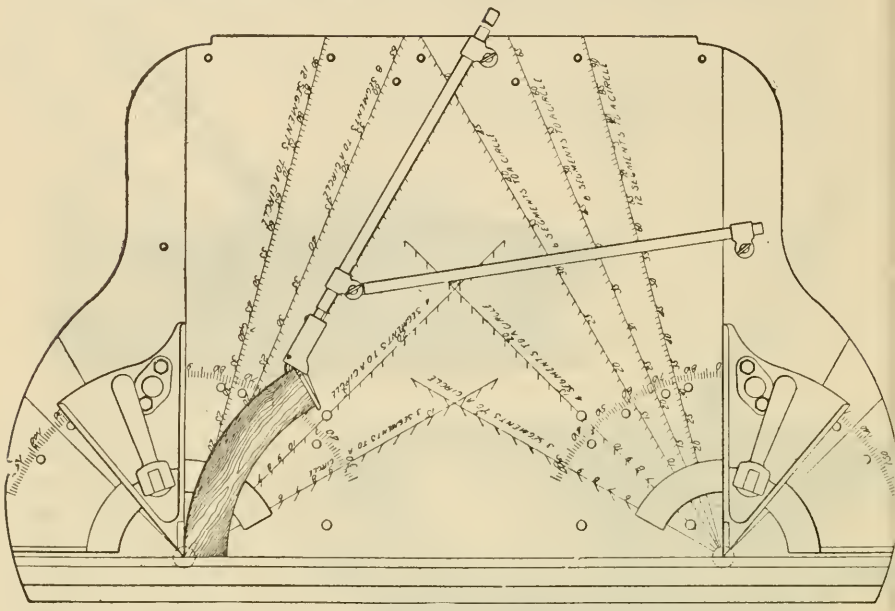


Fig. 63 TRIMMING SEGMENTS

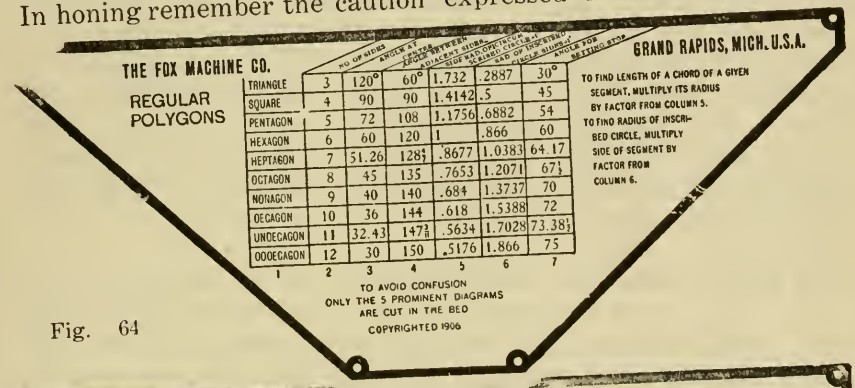
means of a compression spring while the first cut is made. Then when the segment is lifted to reverse ends, it is all ready for making the final cut, the head springs to its position. The bed is graduated on both sides which permits the use of either knife.

Fig. 64 shows mechanical aids which are self-explanatory.

Fig. 65 shows another etching which is also placed on the larger types of Fox Trimmers. This etching in Fig. 65 is primarily intended to illustrate the various number of degrees of a circle contained in a segment or triangle, and secondly, how to obtain the given diameter of a circle for a given number of segments with the aid of a scale and a pair of dividers. Explanation of use follows:- As shown in Fig. 65 assume that it is desired to find the length of chord required for a circle 4" in diameter containing 6 segments of 60 degrees each; set the dividers at 2 the radius of a 4 circle, place one leg of the dividers at the center of the gauge and the other in

the path of the knife. Use the latter point as the center and strike a circle lightly upon the bed just enough to make a visible line at a point where it can be intesected by a line drawn 60 degrees. Next, gauge to 60 degrees measure distance from gauge pointer center to the intersection of 4" circle and 60 degree chord. The result is the required chordlength. The trimmer knives require extreme care in grinding, being much harder than ordinary machine knives. Grind slowly so as to avoid heating and drawing the temper. If burned in grinding, the only recourse is to grind back to the part where the temper has not been drawn, since they cannot be retempered.

In honing remember the caution expressed in Art. 63



	No. of Sides	Angle at Center	Angle between Radius and Chord	Factor to Find Chord from Radius	Factor to Find Radius of Inscribed Circle	Angle for Setting Stop
				5	6	
TRIANGLE	3	120°	60°	1.732	.2887	30°
SQUARE	4	90	90	1.4142	.5	45
PENTAGON	5	72	108	1.1756	.6882	54
HEXAGON	6	60	120	1	.866	60
HEPTAGON	7	51.26	128½	.8677	1.0383	64.17
OCTAGON	8	45	135	.7653	1.2071	67½
NONAGON	9	40	140	.684	1.3737	70
DECAGON	10	36	144	.618	1.5388	72
UNDECAGON	11	32.43	147⅞	.5634	1.7028	73.38½
DODECAGON	12	30	150	.5176	1.866	75
	1	2	3	4	5	6	7

Fig. 64

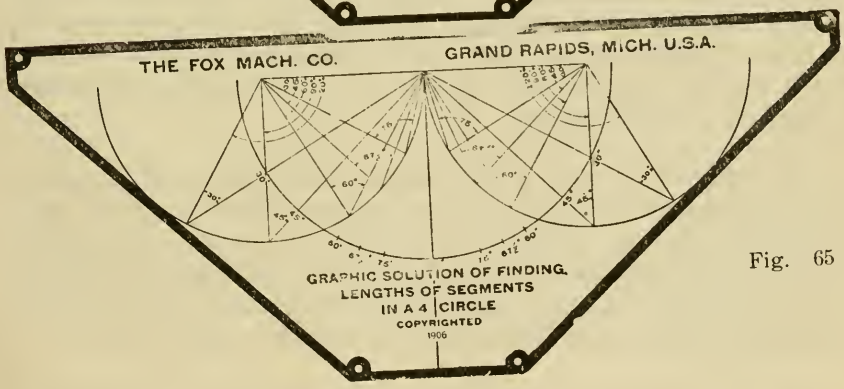


Fig. 65

CHAPTER XII.

DRYING AND STEAMING.

67. General-- The dry and steam box should be a part of every modern wood-working shop where high grade cabinet work is done.

These boxes are best made of iron with coils placed in the bottom of same. If the heating plant is available at all times, a live steampipe may be connected to these coils. Where this is not possible a gas heater can be installed for this special purpose.

The drying box, of course, should be much larger than the steam box. The drying box should open from the front so as to be opened the entire length for placing the long boards in the box. The steam box, of course, must be practically air-tight during operation. It is smaller than the dry box and should open on one end only. The process of steaming is described in Art. 68.

It is to be understood that this dry box is not intended to be a dry kiln. Experience has shown that often when buying kiln dried lumber, it frequently acquires moisture while being brought from the shop and unless it is placed in a lumber room that is well heated, satisfactory glue work does not result unless it is, at least, warmed after it has been prepared for gluing. For this reason the dry box is necessary for good results.

68. Bending Wood and a Shop-made Steam Box-- In selecting wood for bending only good "live" lumber should be used since lumber dried on the stump will not bend. It should be squared to size before bending since all that is done after bending is to clean it up and it is not possible to reduce the sizes materially without a great expenditure of time and effort after pieces have been steamed.

A steam box like the one referred to in the preceding article is not always available and for this reason the simple steam box which is possible for any boy to make in the manual training shop or in his

own shop at home will be described. Square the end of a piece of iron pipe or make a box 8 or 10" square (or larger) and of a length which will inclose the longest piece which you desire to steam. The ends of the pipe should be smoothed so that they can be closed by placing a large plug in them. When resting the box the end must be well squared up and the door or cover can be hinged, using burlap between the end and the cover, to keep the live steam from escaping.

Where the box is to be used only once or twice, it is possible to nail the end in place but this soon makes the box unfit for use.

A good teakettle may take the place of a steam generator. A small piece of pipe is inserted in the side or the top of the steam box and connected with the spout of the teakettle by means of a hose. In placing the steam box, one end should be slightly higher and at the lower end bore a very small hole so that the steam after condensation may escape in the form of water. Steam leaving the box in the form of vapor has not helped to soften the wood and is therefor wasted. For this reason do not crowd the teakettle. If any live steam escapes at the cover or throught joints in the box, it is a good sign that you have too much heat under the teakettle. Be sure in charging the steam box that the pieces are so arranged that the steam can readily get at all sides of each piece. Small pieces can be steamed in 20 minutes and are soft enought for bending. Large pieces require as much as several hours steaming before they are soft enought to bend. Perpare the form for bending by nailing blocks or brackets on the floor or on some bench-top especially prepared for this purpose. These blocks must all be ready for bending the piece to its proper shape before removing it from the steam box. Take the pieces from the steam box one at a time and place in the form quickly. If the piece is exposed to the air any length of time before placing in the form, it will not bend. Leave in a warm dry place until thoroughly hardened and dry before removing from the form.

It is asserted by men of long experience that a steamed rocker is much stronger and more desirable than a sawn one. You will be surprised when making one of these steam boxes to find how simple, bending work really is.

CHAPTER XIII.

GLUE AND GLUE HEATERS

69. General -- It is assumed that students using "Shop Notes" have previously learned how to make a glue joint by hand, hence, it will not necessary to repeat this information since the transition from a glue joint made by hand to the machine made glue joint is brought out in connection with the jointer. But many have had experience of preparing a good glue joint, and after gluing found that it does not hold. For this reason the manufacture of glue will be described and how to properly prepare it for use. This, of course, will be applied principally to hot glues, since the cold glue comes prepared ready for use. About the only information needed in connection with its use is that it must be kept covered when not in use, and should it become too thick, add a small amount of acetic acid, (vinegar).

70 Glue And Its Preparation For Use -- Glue is of two kinds, animal glue and fish glue. Animal glue is made from bones, hides, feet, and trimmings of hides of animals.

Salt is very destructive to glue since it attracts moisture. The first step in preparing glue stock is to remove the salt and foreign matter. In the case of skins and hides it is soaked in lime water. Materials that have bone, hoofs, etc. in them are leached in dilute acid solution.

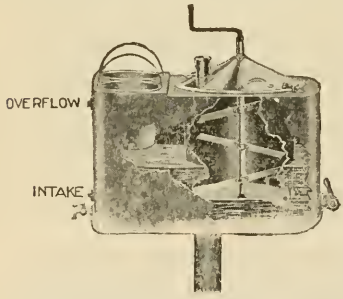


FIG. 66— MIXER AND GLUE HEATER SHOWING CONSTRUCTION.

The stock is then boiled (very similar to the process of making soup) and the liquid (glutinous matter) extracted (called a run) is treated with preservatives, boiled down and dried. The stock may be used a number of times.

Fish glue is made from fish waste comprising skins, head, fins, tails, scales, and bones. The salt is removed by agitating this raw material in cold water for several days before boiling. The gluti-

nous matter is then treated in the same manner as the animal glue.

Liquid, sometimes called cold glue, may be made from either fish or animal glue. The liquid glue cans should always be kept closed when not in use. Should it become too thick or heavy, add a little acetic acid or vinegar. In cold waether, by placing in a hot bath or a warm place.

To prepare hot glue, break it into small pieces and soak for 12 hours in cold water before boiling. Always use a glue pot of the double boiler type, one of which is shown in Fig. 66. This has a mixer as well as the seperate glue pots in which the glue is afterwards placed. It should be the consistency of thin syrup when applied.

The best glue is of a clear amber color and free from spots.

A small wooden paddle makes an excellent spreader.

71. **Glue Heaters**--The glue heater shown in Fig. 66 may be attached to a live steam pipe so as to heat the water for preparing the glue and keeping it heated, or have gas burners placed beneath it. In mixing glue, always keep in mind that glue which has been heated very many times loses its strength. For this reason no more should be mixed at a time than can be used with miuimum number of re-hearings.

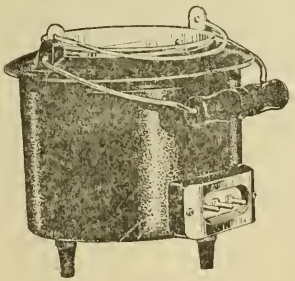


FIG. 67-- THREE-HEAT WATER JACKETED ELECTRIC GLUE POT

Fig. 67 illustrates a water jacketed 3-heat pot. These are made for both from 95 to 125 volts and for 200 to 250 volts, the the latter type of glue pot being more expensive. They are made in various sizes, but usually 1, 2 and4 quart sizes. Pots are usually equipped completely with 3 terminal contact plug, with a cable and a 3-heat wall receptacle.

CHAPTER XIV

EXHAUST SYSTEMS.

72. Exhaust Systems -- A mill room in order to be modern and completely equipped should have an arrangement for carrying out the dust along with shavings, chips, saw-dust, etc., from the different machines while in operation. The arrangement for this purpose is called an exhaust system, and consists of a system of pipes leading from the different machines in the shop to one large outlet pipe, at the end of which is an exhaustor fan which draws out the dust, etc , already mentioned. It drops into an incinerator, or by means of additional pipes is carried to the boiler room where it is used as fuel. It will be an interesting, as well as a profitable, visit for you to go to a modern up-to-date planing mill and see just how the exhaustor system is installed and how it is operated.

A few fundamental facts should be kept in mind. The outlet pipe must be full size until the shavings reach the incinerator or the point where they leave for the boilor room. The intake pipes which lead from the machines to the outlet pipe are smaller (their combined area must not exceed that of the outlet pipe), and the size is determined by the machine which they serve, for instance: the planer depending upon the size requires a 4 or 5" pipe, while the saw requires 3" or smaller. For a school mill room a system having a 12" outlet pipe is ample. This can be operated with a 24" fan.

73. Speed and Power -- The 24" fan just referred to, in order to give efficient service, must run at a speed of 2500 R. P. M. and will require a 5 h. p. motor.

CHAPTER XV
POWER TRANSMISSION

74. General--Belting is the oldest agent for power transmission and still proves to be most effective in spite of the fact that many other agents and devices have been worked out in the last few years. Where belting is not serving effectively for power transmission it is nearly always due to one of two reasons which can readily be removed. Either an inferior grade of belting is used or the belting does not receive proper care and attention.

Only the best grade of leather belting (single and double ply) should never be used. The canvas and so-called rubber belting should ever be advocated where wear and service is desired. The best grade of belting is always the cheapest in the end because it not only lasts longer but costs much less for upkeep. Machines are idle while belts are being repaired this is an expensive proposition.

Every plant should have someone in charge of the belts and no one should be allowed to work on the belts or make any changes in them except under the supervision of the belting man. This is being done in large plants commanded by efficiency experts but is also possible for the small plant because it does not necessarily follow that this man need spend his entire time looking after the belts. The one in charge of this work should be a person who has been specially trained either in the factory where he has had experience in the manufacture of belting or as an apprentice under a belt specialist.

School shops will do well to adopt this shop practice in order to make the work real. To make this effective, belt records, which are to be had for the asking from large manufacturers of belting such as Graton-Knight Manufacturing Company of Worcester, Massachusetts, should be kept systematically. The belt should be periodically inspected so as to determine whether or not it has become too dry, saturated with oil, over-treated with belt dressing, opening up of laps, etc.

75. General Care—Belts, in order to render the most effective service and wear as long as possible, should, at all times, be kept soft and pliable. To do this, too much grease and mineral oil should be avoided as they rot the leather. (Particularly is this true of the mineral oil.)

When a belt has become too dry, the surface should first be cleaned by rubbing with a cloth dampened with kerosine. Then apply a thin coat of Neat's Foot Oil to each side of the belt. Apply a second coat and as many more as are necessary to give the belt that mellow feeling which is characteristic of a good working condition. This should be repeated monthly for a belt which sees hard service. There are specially prepared compounds put out by the standard manufacturers of belting supplies that have nothing in them which is injurious to leather and are said to be better than the Neat's Foot Oil.

Grease and oil is not only injurious to the leather, but cause friction, thereby wasting power. Belts must always be protected from the oil wherever possible, but where this is impossible, they should be cleaned periodically with naphta or carbon tetrachloride.

Oil also injures the sticking qualities of ordinary cement and is the cause of laps beginning to open at the points. Once the lap begins to loosen at the point it should be repaired by first removing the oil and then gluing. Driving tacks through the joint or a heavy cast iron belt fastener weakens the piece of leather and causes a bump of the belt every time the piece of metal goes around the pully.

Always use sticky belt dressing very sparingly and then only when absolutely necessary. Sticky belt dressing if used to a consderable extent sticks the pully to the belt so tightly that it pulls the grain off the belt, works into the leather causing it to rot. If the pulleys are properly lined up the belts will stay on and a preservative is very much to be preferred to a sticky belt dressing.

76. Splicing (Wire, Whang, Belt hooks and Glue)—Belts may be spliced in a number of ways. However, there is only one really efficient method for splicing belts, and that is to glue them.

Belt hooks are sometimes used and are perhaps to be recommended for cheap rubber belts which are sometimes used on farm machinery.

Raw hide or whang lacing is often used to advantage when belts are run at a low speed; but this usually causes a noise referred to as "pounding" which is not desirable; and it must be remembered that lacing reduces the strength of the belt one-third at the splice. To somewhat reduce the pounding at the joint, wire lacing may be used which, although not noiseless is less noisly than the whang lacing. It is quite satisftactory on pulleys of large diameters but has a tendency to break when used on very small ones. This makes it dangerous if used for lathe and other small pulley belts that must be shifted by hand. Where a large number of belts are kept up by the use of wire lacing, a machine is used which makes it possible to splice by means of wire lacing very quickly. The endless or glued belt, as already stated, is the most satisfactory and particularly is this true of high speed machines since the splicing is noiseless.

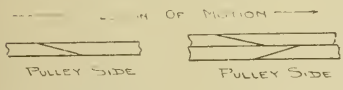


Fig. 68 SINGLE AND DOUBLE PLY SPLICES

The two types of endless belts are shown in Fig. 68, and are known as single and double ply splices. Preparatory to splicing, the ends of the belt should be planed back as far as the belt is wide. In other words, the lap should be square. Place together on a board so as to use one edge as a straight edge in order to keep the edge of the belt straight. Otherwise one side of the belt will be made to assume more than its part of the strain in use. Apply a coat of belt glue very much the same as in gluing wood. The glue should be about the consistency of thick syrup. After the laps have been put together use a hammer working from center out in order to work out any surplus glue. Place a piece of paper on the joint and then apply a wood hand clamp to hold it in place. It is best to leave it from two to six hours before using; although some manufacturers insist that when their glue is used, belts may be used after having set for from one-half to three-quarters of an hour. When gluing a belt, the lap of which is larger than the hand clamp will

cover, place a board over the joint and then clamp over this and the board on which the belt is resting. With very large belts, a portio of the joint must be glued at a time since chilled glue positively has no sticking qnalities. It sometimes happens that a belt must be put on the pulleys before gluing. Where this is the case a belt clamp and rods is necessary. The belts are drawn over the pulleys but care must be exercised to have them so that the hide or grain side will run next to the pulleys and so that the points of the lap will run against the pulleys. The lap on the outside of the belt is likely to come loose if run against the air pressure (see Fig. 68). The general instructions are the same. Outside of this exercise care in drawing up the rods, making a final test just before gluing. If in this test you find it necessary to draw up either one of the rods so as to bring it into line, refit the lap before gluing, if necessary. The board previously mentioned in this case should be wide enough to go between the rods and long enough to extend under the entire lap. It may be strapped to the rod in such a way that you can shave the lap down and fit it.

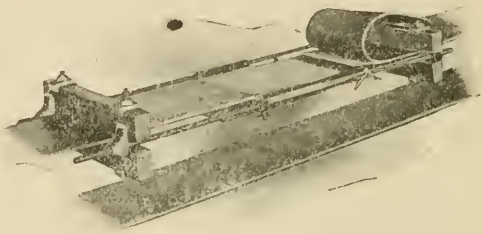


Fig. 69 BELT CLAMP AND RODS

Figs. 70 to 73 illustrate the simple method of **using wire lacing.** The ends of the belt should first be squared and the holes punched opposite each other and only as far back from the end as the thickness of the belt. The distance apart should be so that approximately 9 holes are punched for every 4"

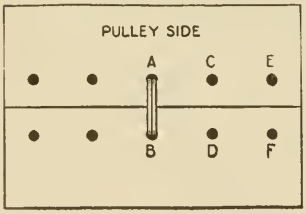


Fig. 70 SIMPLE METHOD OF LACING.

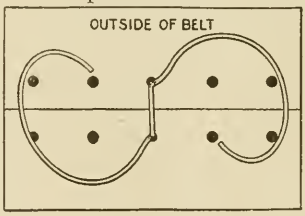


Fig. 71

of belting. The ends of the belt are placed together for lacing and to hold them steady, binders should be placed in the holes nearest the edges of the belt. A piece of lacing seven times the width of the belt should be used for the single and nine times the width of the belt for double. Wire should be inserted over the pulley side beginning with the holes nearest the center of the belt as shown in figure 70. Double lace this hole as shown in figure 70 and 72 and cross to the next holes towards the outside of the belt as shown in figure 71. Use pliers to draw the ends of the wire up tight, but do not stretch. Double lace each side of the holes keeping the holes straight strands on the pulley side. Remove the binder and double lace on both outside holes and run the end of the wire across to the next hole on the pulley side as shown in figure 72 and bring up on the outside of the belt, cut off $\frac{1}{4}$" and flatten the ends down as shown in figure 73. After lacing in this manner, hammer down flush with the pulley on the pulley side. Rubber belts are laced in the same manner, but a belt awl is used instead of a punch: Sizes for wire lacing are as follows:

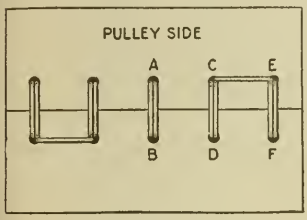


Fig. 72

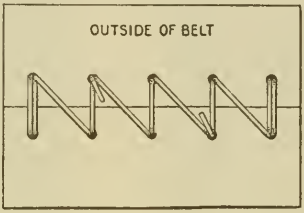


Fig. 73

No. OO For light single belts up to 1".
No. O For single belts under 3" wide.
No. 1 For single belts 3" to 5" wide.
No. 2 For wide single and narrow double belts.
No. 3 For all double belts above 6" wide.

There are several styles of lacing a belt when **using whang or** lacing leather. The chart shown in figure 74 gives the proper sizes for punching holes. Large lacing holes and excess lace are harmful

and should be as religiously avoided as the iron belt clamps an tacks.

In squaring the belt for lacing always cut, using a try square. The holes in both ends of the belt should be exactly opposite and no hole should be less than $\frac{1}{4}$" from the **edge** of the belt nor nearer the **end** than $\frac{1}{2}$". The holes should be placed approximately $\frac{3}{4}$" from center to center. For width of lacing and the proper sizes of holes for the various widths of belting, see chart, figure 74.

Punch Number	Diam. of Hole	Recom'd Width of Lace	Width of Belt	Weight of Lace
6	$\frac{11}{64}$	$\frac{1}{4}$		Light
7	$\frac{3}{16}$		Up to 5	
8	$\frac{1}{4}$	$\frac{5}{16}$		Light
9	$\frac{9}{32}$	$\frac{3}{8}$		Medium
10	$\frac{5}{16}$	$\frac{7}{16}$	6 to 14	Medium
11	$\frac{3}{8}$	$\frac{1}{2}$		Heavy
12	$\frac{13}{32}$	$\frac{5}{8}$ & $\frac{3}{4}$	14 & over	Heavy

Fig. 74 LACING SPECIFICATIONS

Lacings come in bundles of 100 feet and varies in width. These lacings are very strong and the best ones are made from imported India cow hide taken from the hides of young animals so as to secure freedom from grubs, cuts, and other imperfections. The lacing from $\frac{1}{4}$" to 5-16" are known as light weight and 3-8" to 7-16" as medium. Larger sizes than these are designated heavy.

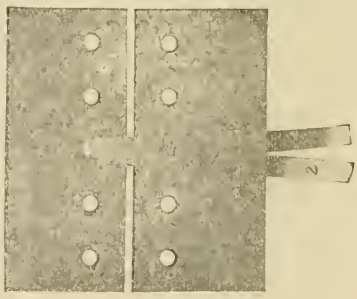


Fig 75— STRAIGHT STITCH LACE FOR ODD NUMBER OF HOLES

The style known as the **straight stitch lace** figures 75, 76, 77 and 78 will first be described. Figure 75

shows a lace for an uneven number of holes. (a) The lace is first placed through the central holes, 3 and 8, then draw the ends even as shown in the illustration. Next put No. 1 up through No. 3 and down through No. 8 so as to double lace the center. Next put it

Fig. 76— FLESH SIDE FOR ODD NUMBER OF HOLES

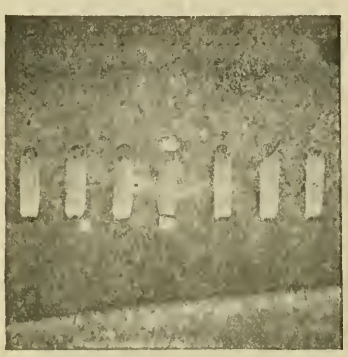


Fig. 77— GRAIN SIDE FOR ODD NUMBER OF HOLES

through No. 4, down through No. 9, up through No. 5, down through No. 10, up through No. 5, down through No. 10, up through No. 4, down through No. 9, and up through No. 3. Punch holes with belt awl and then fasten directly back of hole No 3, as shown in Fig. 76

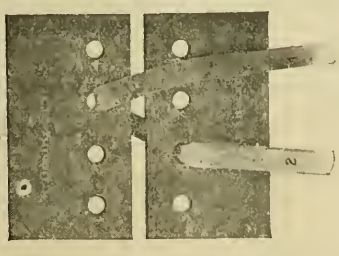


Fig. 78— BEGINNING LACE FOR EVEN NUMBER OF HOLES

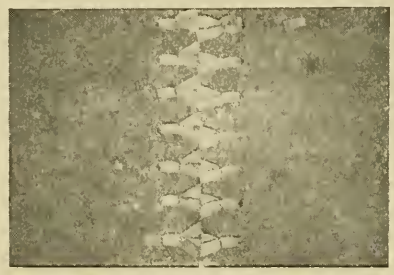


Fig. 79— HINGE LACE LOOK SAME ON BOTH SIDES OF THE BELT

and 77 (b) Next put lace No. 2 up through hole No. 7, down through No. 2, up through No. 6, down through No. 1, up through No. 6, down through No. 1, up through No. 7, down through No. 2, up through No. 8 and fasten same as No. 1. This order applies to any uneven number of holes and no difficulty will be experienced if you begin with the center holes.

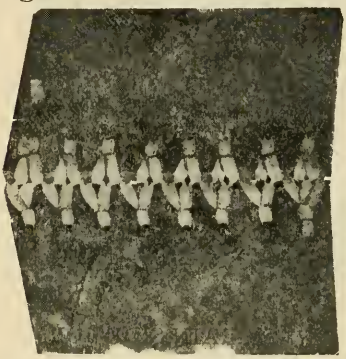


Fig. 80.— Hinge Joint Avoids Stiff Lace

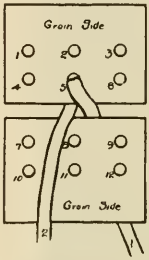


Fig. 81. — Hole punched and beginning of lace for hinge lace.

When a belt is of a width requiring an even number of holes begin as shown in Fig. 78. Then put lace No. 1 down thru hole No. 7, up thru No. 4, down through No. 8, up through No. 4,

Continued next page.

77. **Belting Rules.** When using pulleys of equal, or nearly equal size without idlers and the arc of contact is 180° each, the following formula may be used to determine the proper belt to be used.

Speed in ft. per min. (S.F.P.M.) = pulley diameter in ft. x 3. 1419 x R.P.M. of pulley.

H.P. = (S.F.P.M.) x width of belt in inches x 55. (working tension or effective pull) product divided by 33,000 and the quotient will be for single belt. The result obtained for single belt if multiplied by 1.6 will give the result for double and if multiplied twice for three-ply belting.

The width of belting: = Given H.P. x 33,000 product divided by product of belt speed in feet per minute x 55 for single belts; 88 double; three-ply 110 (working tension or effective pull).

In the rule just given the 55 for single belts; 88 for double; and 110 for three-ply is the "working tension or effective pull" where the arc of contact is 180°. CONTINUED ON PAGE 81.

down through No. 8, up through No. 3, down through No. 7, and up through No. 2. Then with a belt awl, punch a hole and fasten directly back of No. 2 as in Figs. 76 and 77. Then put lace No. 2 down through hole No. 2, up through No. 5, down through No. 1, up through No. 5, down through No. 1, up through No. 6, down through No. 2, up through No. 7 and fasten in the same manner back of hole No. 7. In this case only four holes to a row were used.

However, the same instructions apply when using any even number of holes.

In order to lace for **"hinge" plan,** as shown in Figs. 79 and 80, punch the ends as shown in Fig. 81. Put the lace through No. 5 and draw ends even. Then put the ends of the belt together and pass each strand of the lace between the ends of the belt as shown in figure. Then pass No. 1 lace up through No. 8, down between ends of belt, up through No. 5, down through No. 2, up through No. 5 and down between ends again. Put lace No. 2 down through No. 8, up through No. 11 down through No. 8, up between ends, down through No. 4, up between ends, down through No. 7, up between ends, down through No. 4, up through No. 1, down through No. 4, up between ends, down through No. 7, up through No. 10, down through No. 7, up between ends, down through No. 4, up through No. 1. Punch hole with belt awl and fasten directly back of No. 1. Reverse this process in lacing through half of the belt, fastening the ends of the lace back of hole No. 12. These instructions apply for any odd number of holes to the row. When the width of the belt requires an even number of holes to the row, begin with either one of the two center holes, and follow the same instructions.

78- DRIVE AND SPEEDS.

78a- Drive.

The drive as a rule, consists of the pully which transmits the power to the belt. However, in some cases it is directly connected by means of a friction clutch or a flexible coupling, to the machine that is to be driven. In the case of a gear drive a chain is used instead of a belt.

78 b-The Driven.

This usually applies to the pully to which the power is transmitted from the drive. However, in the case of the direct drive it would be the shaft, or, the pully on the friction clutch which operates the machine.

78 c-Speed.

The term speed has reference to the number of revolutions made by the pulley per minute, and is designated by the letters R.P.M., meaning revolutions per minute.

78 d-Rules for Speeds of Pulleys.

The diameter of the driving pulley (D) multiplied by its speed (S) is equal to the diameter of the driven (d), multiplied by its speed (s) .

Surface speed, also referred to as cutting speed in connection with the turning lathe, saws, etc., refers to the number of lineal feet measured on the surface of the work that pass the cutting edge of the tool in one minute.

78 d-Rules for Surface Speed. The number of feet in the circumferance of the work or the tool being turned, multiplied by the number of revolutions per. minute gives the surface speed in feet per. minute.

78 e-Formula for Speed of Pulleys. If D represents the diameter of the driving pulley and d represents the diameter of the driven pulley, S, the speed of the driving pulley, s the speed of the driven pulley, then DS equals ds. For cutting speed, if C equals the cutting speed and c equals the circumference of the work or the tool that is cutting, then c x R. P. M. equals C.

For example, a 36" Band Saw with a 12" drive pulley to be run from 500 to 600 R. P. M. is being installed. A 3 horse power motor with a speed of 1800 R. P. M. is to be used for the drive. What size pulley will be needed on the motor?

Substituting in the formula DS equals ds. We have D x 1800 equals 12 x 600. 12 x 600 equals 7200 divided by 1800 equals 4 or D, the size of pulley neccessary to drive the Band Saw at its proper speed.

78f. **Exercises.** 1. Find the cutting speed of the band saw in the preceding paragraph.
2. Measure the drive and driven pulleys on the saw table and find the R. P. M. of the saw arbor? What is the surface speed each for a 10" and a 12" saw when run at this speed? In using speed indicator, Fig. 86, what do you find to be the R. P. M. of the saw arbor?
3. Substitute the swing saw for the saw table in problem 2 and solve.
4. Verify the speeds of the other machines in the shop.
5. Instructor will dictate lists of problems providing local application of formulæ and rules in Arts. 77 and 78.

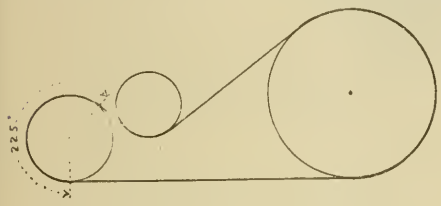


Fig. 82— ARC OF CONTACT

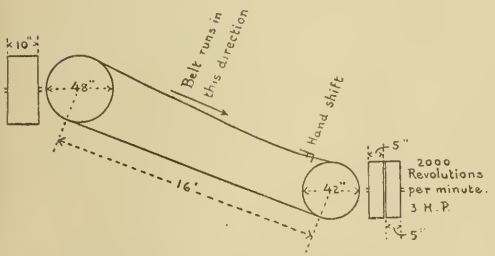


Fig. 83— BELTING SPECIFICATION SKETCH

Continued from page 78.

To find the working tension or effective pull when arc of contact is not 180°; multiply arc of contact x 155 for single belt, 88 for double, and 110 for three-ply and divide this product by 180.

To find arc of contact, Fig. 82, draw line or tape over pulleys as indicated and use protractor to find number of degrees.

When ordering belting in large quantities it is advisable to consult the manufacturer and send in sketch as shown in Fig. 83. The length may readily be obtained by drawing a tape over the pulleys in the position the belt will assume when in use. The length necessary for lap, Fig. 84, varies with the width of the belt, and should be as long as the belt is wide.

To find the number of feet of belting in a roll, divide the diameter of the roll by 2, multiply by 3 1/7, and this result by the number of

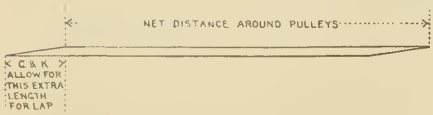
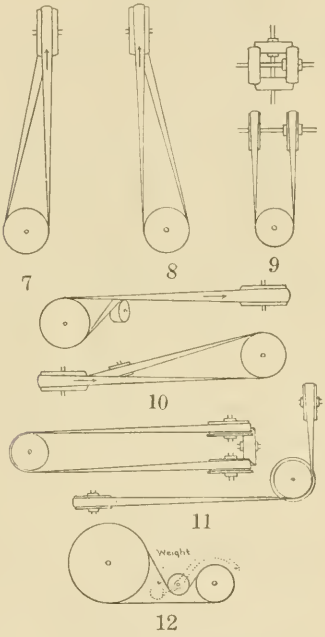


Fig. 84— BELT LENGTH

coils in the roll. If there is a hole at center of the roll, add its diameter to the outside diameter before dividing by 2.

Common drivers are represented and named in Fig. 85.



7, Quarter turn to left; 8, Quarter turn to right; 9, Four pulley quarter-turn drive; 10, (Elevation and plan,) Three pulley quarter-turn drive; 11, (Elevation and plan) Mule Drive; 12, Lenix Drive.

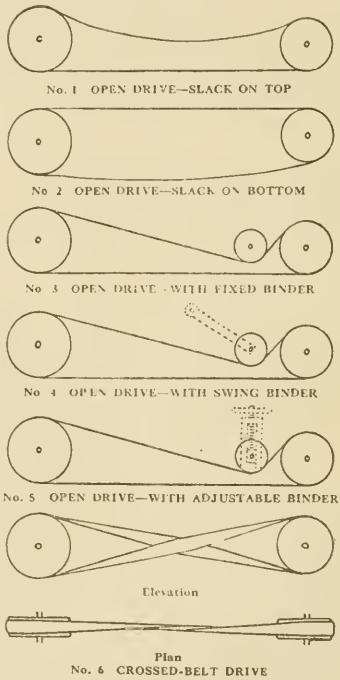


Fig. 85— COMMON DRIVES

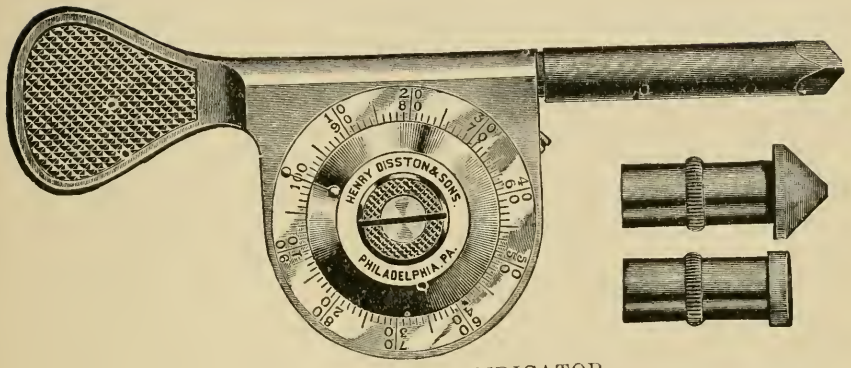


FIG. 86—SPEED INDICATOR

CHAPTER XVI.

WOODWORKING AND GENERAL SAFETY ORDERS.

79 Safety Provisions of the Workmen's Compensation, Insurance and Safety Act, Chapter 176 of the Law of 1913.

Sections 51 to 72, inclusive, of the Workmen's Compensation, Insurance and Safety Act give the Industrial Accident Commisson power to make and enforce safety orders, rules and regulations, to prescribe safety devies, and to fix safety standards. It also empowers the Commission to appoint advisors who shall, without compensation, assist the Commission in establishing standards of safety. The Commission may adopt and incorporate in its general orders such safety recommendations as it may receive from such advisors.

As a result of this, the commission asked various allied interests to serve on sub-committees to draft the Wood Working Safety Orders. The sub-committees were not named until the committee on General Safety Orders had organized in San Francisco and Los Angeles had been consulted. The General Safety Orders Committees prepared the General Safety Orders which went into effect January 1st. These committees prepared the orders which follow under separate Arts. and which have been effective since August 1st, 1916.

80. Circular Rip Saw. Order 600. All circular saws must be guarded by hooded guards and must be provided with spreaders or splitters and or dogs, which shall be located at the rear of the saws. Guards must also be provided to prevent contact with that part of the saw which is underneath the table.

Exception. Where special work is being done, such will prevent the use of a guard and or splitter or dogs, such guard and or splitter or dog may be omitted, but in case where such special work is temporarily carried on, a guard and or splitter or dogs must be provided and put in place during all operations other than that involved in special work.

81 Crosscut Saws. Order 600. (a) All crosscut saws of the swinging

type must be guarded. Knuckle guards must be attached to the swing frame. (b) All swing cut-off saws must be provided with a device which will return the saw to the back of the table and prevent a rebound. (c) Means shall be provided on swing cut-off saws to prevent the counterweight throwing the saw forward into the travel. (d) The rear side of crosscut swing saws must be guarded. (e) All circular crosscut saws must be guarded by hoods where the saws are held on fixed horizontal bearings.

82 Band Saws. Order 602.

(a) Guards must be installed to cover both upper and lower wheels of all band saws.

The up-travel of all band saws must be completely guarded, and the down-travel must be guarded with a shield extending down to the guide rolls.

83. Wood Jointers. Order 603.

(a) All wood jointers must be equipped with cylindrical cutter heads of the safety type.

(b) A suitable automatically adjusted guard must be placed over the whole cutting space in the table.

84. Sanding Machines. Order 604.

(a) Disc sander must have the circumference and back of the revolving head thoroughly guarded.

(b) Belt sanders must have both pulleys enclosed.

85 Mortising Machines Order 605.

(a) Thumb guards must be provided on all mortising machines, to prevent the hands of the operator from coming in contact with the chisel except on mortising machines of such type that it is not required to use a clamp which would bring the hands of the operator into close proximity to the cutting edge.

86 Shapers Order 606

(a) All knife heads of wood shapers and similar heads of other machines, not automatically fed, must be guarded, or forms must be used in which the part operated on is securely fastened.

Exception. Where special work is being done which will prevent the use of a guard, said guard may be omitted, but in cases where such special work is temporarily carried on, a guard must be provided to put in place during all operations other than that involving special work.

(b) All knife heads of woodworking machines which are automatically fed, such as stickers, planers, etc., when exposed to contact, must be guarded.

87. Tenoning Machines. Order 607. (a) Cutting heads and saws of tenoning machines must be guarded.

88. Lighting. Order 608. (a) Ample light, either natural or artificial, must be provided around woodworking machinery.

89. Gears, etc. Order 609. (a) All gears, belts, pulleys and sprockets and shafting connected with woodworking machinery, shall be guarded in accordance with the General Safety Orders issued by the Industrial Accident Commission.

90. Multiple Unit Drive. Order 610. (a) Where practicable, not more than ten machines shall be driven in one unit. Where a greater number than ten machines are driven from one line shaft, a clutch, tight and loose pulley shifter, switch, idler or other mechanical means shall be provided in that room or department which will immediately stop all machinery in that group.

NOTE. – The prompt stoppage of machinery in emergencies is hastened by allowing the full load to remain on all machines. It is of vital importance that a proper starting and stopping device be provided in the room or department in cases where engines or motors are located in another department or in another building.

91. Recommendation. It is recommended that floors where operators stand to operate machines, such as wood-shapers, jointers, saws, etc., should be provided with nonslip surfaces and kept clear of waste material.

GENERAL SAFETY ORDERS

92. **Gears.** Order 1. (a) All gears, where exposed to contact, must be entirely enclosed, or equipped with side flanges extending inward beyond the root of the teeth.

(b) All spoke gears and open web gears, which are over eighteen (18) inches in diameter, where exposed to contact, must be entirely enclosed. On large gears, such as those on heavy shears and punches, the guard must be such as to cover them to a height of seven (7) feet above the floor.

(c) Where it is clearly impracticable to cover gears, as described above, a boxed frame of metal or wood must be installed, completely shutting off the machinery gears.

(d) All gear guards must be kept in place while the machinery is in operation.

93. Belts. Order 2. (a) All belts, ropes or chains driving machinery or shafting, and all secondary belts, ropes or chains where exposed to contact, must be guarded. In all cases the point where the belt, rope or chain runs on to the pulley, sheave or sprocket, if within seven (7) feet of the floor or platform, must be guarded.

Exception: Belts which are so small or so slow moving that they are not in any way a source of danger.

(b) All horizontal belts, ropes or chains driving machinery or shafting, seven (7) feet or less above the floor or platform, where exposed to contact, must be guarded. All overhead belts six (6) inches or more in width and over seven (7) feet from floor or platform, must be guarded underneath and on sides, unless so guarded that persons can not pass under them. All chain or rope drives over seven (7) feet from floor or platform must be guarded in like manner to belts over six (6) inches in width. In all cases the guard should cover the outer faces of the two pulleys or sheaves and extend upward to such a point, and be attached in such a way, that in case the belt, chain or rope breaks, the guard will withstand the whipping force.

(c) Vertical and inclined belts must be substantially guarded as follows:

1. If the guard must be less than fifteen (15) inches from the belt, with a complete enclosure of wood or metal to a height of six (6) feet above the floor.

2. If the guard can be placed within at least fifteen (15) inches clearance from the belt, with a two-rail railing at least three and one-half (3½) feet high.

Note.—In rooms, or parts of rooms, used exclusively for transmission machinery, such as the ground floor of sawmills and the basements of paper mills or flour mills, it has been found practical to define certain passageways for the use of oilers and millwrights, and to guard the pulleys, belts and shafts along these passageways.

94. Pulleys. Order 3. (a) Pulleys must be so placed as to allow the width of the belt between two pulleys, or between the pulley and

the shaft hanger or bearing, or a hook must be provided, or a guard placed adjacent to the pulley to prevent the belt from leaving the pulley.

(b) All machines must be equipped with a loose pulley or a clutch or some other adequate means of stopping the machine quickly.

(c) All pulleys or parts of pulleys within seven (7) feet of the floor must be guarded, if exposed to contact.

95. Clutches. Order 4. (a) All clutches must be completely guarded where exposed.

Note.—Practically all clutches have protruding parts which make them as dangerous as projecting set screws on shafting.

96. Belt Shifters. Order 5. (a) A permanent belt shifter must be provided for all loose pulleys, and must be located within easy reach of the operator. The construction of belt shifters must be such as to make it impossible for the belt to creep back onto the tight pulley. All belt shifters must be equipped with a lock or some other device to prevent accidental shifting.

97. Shafting. Order 6. (a) All transmission shafting, either horizontal or vertical, in workrooms or in passageways leading to workrooms, and located within seven (7) feet of the floor or platform, must be guarded.

(b) Dead ends of shafts less than seven (7) feet from the floor or platform, or wherever exposed to contact, must be guarded.

98. Set Screws. Order 7. (a) All projecting set screws on moving parts must be removed, countersunk, or protected by a solid collar, or a headless set screw must be used. No part of the set screw must project above the surface.

99. Sprockets. Order 8. (a) All sprockets must be guarded, if exposed.

100. Flywheels. Order 9. (This applies to flywheels of machines and not to flywheels of engines, which must be guarded in accordance with Safety Orders for Stationary Engines.)

All parts of flywheels with spokes, which are seven (7) feet or less above the floor, must be guarded as follows:

(a) If guard is at least fifteen (15) inches in the clear from both sides and face of wheel, a fence may be used at least three and one-half (3½) feet high, to be either solid or of substantially supported wire mesh or close slats.

(b) If guard is less than fifteen (15) inches in the clear from both sides and face of wheel, a fence must be provided at least five (5) feet high, the fencing to be either solid or of substantially supported

wire mesh or close slats.

Exception: Flywheels which are so small, or so slow moving that they are not in any way a source of danger.

(c) All flywheel pits must be surrounded with a toe-board not less than six (6) inches in height.

101. Grinding Wheels. Order 10. (a) Where practicable, grinding wheels must be provided with a hooded guard of sufficient strength to withstand the shock of a bursting wheel This guard must be adjusted close to the wheel and extend forward over the top of the wheel to a point at least thirty (30) degrees beyond a vertical line drawn through the center of the wheel.

(b) Arbor ends must be guarded.

(c) Speed of wheels must not exceed the speed guaranteed by the manufacturer.

(d) Where practicable, grinding wheels must be provided with safety flanges.

Note.—Wheels should be handled with the greatest care in unpacking, storing, delivering, etc., and should never be left standing on the ground or wet places. Great care should be used in mounting wheels; never force a wheel on the arbor. It is advisable to use relieved flanges, compressible washers between wheel and flange, and to obtain a perfect bearing at the outer edge of the flange. Vibration should be avoided at all times.

Diameter of wheel in inches	Revolutions per minute for surface speed of 4,000 feet	Revolutions per minute for surface speed of 5,000 feet	Revolutions per minute for surface speed of 6,000 feet
1	15,279	19,099	22,918
2	7,639	9,549	11,459
3	5,093	6,366	7,639
4	3,820	4,775	5,730
5	3,056	3,820	4,584
6	2,546	3,183	3,820
7	2,183	2,728	3,274
8	1,910	2,387	2,865
10	1,528	1,910	2,292
12	1,273	1,592	1,910
14	1,091	1,364	1,637
16	955	1 194	1,432
18	849	1.061	1,273
20	764	955	1,146
22	694	868	1,042
24	637	796	955
26	586	733	879
28	546	683	819
30	509	637	764
32	477	596	716
34	449	561	674
36	424	531	637

Table of Grinding Wheel Speeds

The revolutions per minute at which wheels are run is dependent

on conditions, and in actual practice wheels are run at surface speeds of from 4,000 to 6,000 feet per minute up to as high as 7,500. It is recommended that for most grinding operations surface speeds should not exceed 6,000 feet. As a wheel wears down the speed is increased to maintain the same surface speed, and great care must be exercised when a new wheel is provided to avoid over-speeding.

102. Ladders. Order 11. (a) All movable ladders (except substantial stepladders) must be provided with either sharp points at the foot or wide, rough surface feet, or other effective means to prevent slipping. Ladders for use in oiling overhead shafting, where necessary to rest the same on the shafting, must be arranged to hook over the shafting.

103. Stairways. Order 12. All stairways must be equipped with handrails, the top of which shall be thirty (30) inches vertically from the nose of the tread, as follows:

(a) Where the stairway is not built next to a wall or partition, rails must be placed on both sides.

(b) If stairway is closed on both sides, at least one handrail must be provided.

(c) If width is greater than four (4) feet, rails must be provided on each side.

(d) If width is eight feet or greater, rails must be provided on each side and in center of stairway, except in cases where in the judgment of the Industrial Accident Commission a center railing would be impracticable.

(e) All stairways must be properly lighted either by natural or artificial light.

Note. Stairways should not be built at a sharper angle than fifty (50) degrees. For sharper angles, ladders should be used instead.

PRINTED BY 6. 7 AND 8TH
GRADE PUPILS IN THE
PREVOCATIONAL SCHOOL
STOCKTON. CALIF.